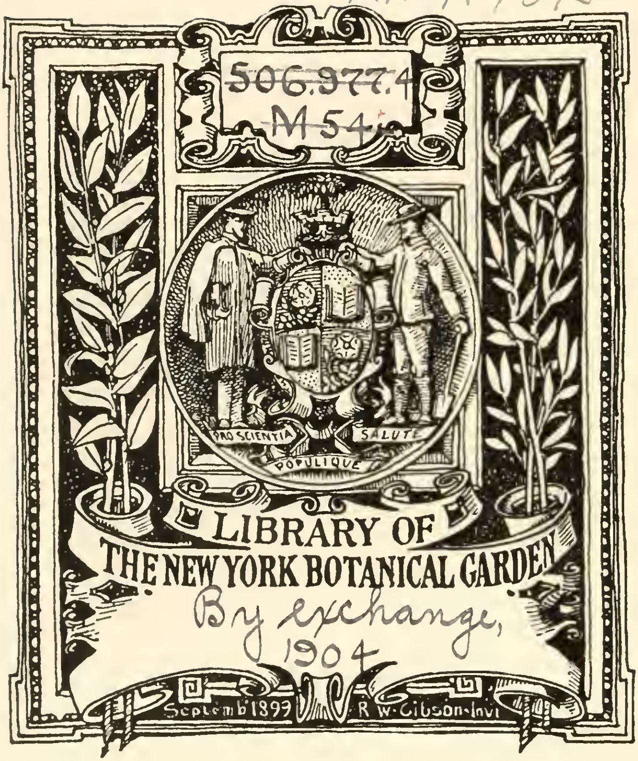
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SECOND REPORT

OF THE

MICHIGAN ACADEMY OF SCIENCE

FOR THE YEAR ENDING JUNE 30, 1900

Acknowledgments and exchanges for the Academy should be sent to the present Secretary, Dr. J. B. Pollock, Ann Arbor, Michigan.

W. B. B.

October, 1901.

BY AUTHORITY

1901
WYNKOOP HALLENBECK CRAWFORD CO. OF LANSING, MICH.
STATE PRINTERS

SECOND REPORT

OF THE

MICHIGAN ACADEMY OF SCIENCE

FOR THE YEAR ENDING JUNE 30, 1900

PREPARED UNDER THE DIRECTION OF THE COUNCIL

By WALTER B. BARROWS, Secretary

BY AUTHORITY

1901
WYNKOOP HALLENBECK CRAWFORD CO. OF LANSING, MICH.
STATE PRINTERS

SECOND REPORT

OF THE

MICHIGAN ACADEMY OF SCIENCE

LETTER OF TRANSMITTAL

To Honorable Hazen S. Pingree, *Governor of the State of Michigan:*

Sir—I have the honor to submit herewith the Second Annual Report of the Michigan Academy of Science, for publication in accordance with Section 14 of Act No. 44, of the Public Acts of the Legislature in 1899.

Respectfully,

WALTER B. BARROWS,

Secretary of the Michigan Academy of Science.

Agricultural College, Mich.,
November 30, 1900.

TABLE OF CONTENTS.

SIXTH ANNUAL MEETING.

Agricultural College, March 29-30, 1900.

The sixth annual meeting of the Michigan Academy of Science was held at Agricultural College, March 29 and 30, 1900.

In addition to the papers presented, a list of which will be found on the following page, the following items of business were transacted.

The minutes of the fifth annual meeting were read and approved.

The treasurer, Professor W. H. Munson, submitted his report, showing the receipts for the year to have been $90, the expenses for the year $41.04, and the balance on hand, $156.74.

The following were elected resident members of the Academy: George M. Bradford, Agricultural College; Hubert L. Clark, Olivet; Ida May Hopson, Detroit; J. A. Jeffery, Agricultural College; James H. McFarlan, Flint; H. W. Mumford, Agricultural College; J. B. Pollock, Ann Arbor; Wm. T. Shaw, Agricultural College; J. D. Towar, Agricultural College; Harry S. Warren, Detroit; Frank Wells, Lansing.

The secretary read a brief obituary notice of Asa Edson Mattice, of Concord, Mich., a resident member whose death occurred March 21, 1900.

Mr. Bryant Walker, from the Committee on Natural History Survey, made a brief verbal report and at his request the committee was continued.

Professor Jacob Reighard, from the Committee on Science Teaching, made a verbal report of progress, which was accepted and the committee continued with its original powers and prerogatives.

A committee of three (with power to add to its numbers) was appointed by the president to take such steps as might seem necessary for the better protection of the wild birds of the State. The members designated were Walter B. Barrows, Agricultural College, L. Whitney Watkins, Manchester, and Wm. H. Munson, Hillsdale.

A resolution was adopted requesting each Section of the Academy to elect a secretary who shall keep minutes of all matters of interest transpiring in that Section, such minutes to be turned over to the general secretary at the close of each annual meeting.

The following were elected officers for the ensuing year:

President—Charles E. Barr, Albion.

Vice Presidents—Section of Botany, Chas. F. Wheeler, Agricultural College; Section of Zoölogy, Bryant Walker, Detroit; Section of Sanitary Science, Frank Wells, Lansing; Section of Agriculture, J. A. Jeffery, Agricultural College.

Treasurer—Wm. H. Munson, Hillsdale.

Secretary—Walter B. Barrows, Agricultural College.

PAPERS PRESENTED AT THE SIXTH ANNUAL MEETING OF THE MICHIGAN ACADEMY OF SCIENCE, AGRICULTURAL COLLEGE, MARCH 29-30, 1900:

(An * before the title indicates that the paper or an abstract appears in this report.)

* (1) Scientific Uses of Michigan Folk Lore.—Harlan I. Smith, New York.
* (2) The Prehistoric Ethnology of the Thompson River Region.—Harlan I. Smith, New York.
* (3) Asexual Dimorphism and the Origin of Sex.—Chas. E. Barr, Albion.
* (4) Some of the Unsolved Problems in Michigan Forestry.—W. J. Beal, Ph. D., Agricultural College.
* (5) Review of Hitchcock's *Geological History of Oahu.*—A. B. Lyons, Detroit.
* (6) Address of the retiring President, Jacob Reighard, Ph. B.—The Biological Sciences and the People.
(7) Coal, its Origin and Occurrence.—Alfred C. Lane, Ph. D. Lansing. Stereopticon Lecture.
(8) Four Interesting Fungi.—B. O. Longyear, Agricultural College. Illustrated with specimens and charts.
(9) Two New Species of Michigan Fungi.—B. O. Longyear, Agricultural College. Illustrated with specimens and charts.
*(10) Catalogue of the Flora of Detroit.—O. A. Farwell, Detroit.
(11) Origin of the Ohio Flora and its Relation to that of Southern Michigan.—J. W. T. Duvel, Ann Arbor.
(12) Systematic Relations of the Fumariaceae from a Chemical Point of View.—Julius O. Schlotterbeck, Ann Arbor.
(13) Anatomical Distinctions of *Juniperus communis* and *J. virginiana.*—Ida M. Hopson, Ann Arbor.
(14) *Crucigenia rectangularis*, Morren.—Dr. Julia W. Snow, Ann Arbor.
(15) Passing of the Native American.—Cressy L. Wilbur, M. D., Lansing. Discussion led by Hon. Lucius C. Storrs, Secretary of the State Board of Charities and Corrections.
*(16) The Infectiousness of Milk from Tuberculous Cows.—Henry B. Baker, M. D., Lansing. Discussion led by C. E. Marshall, Ph. B.
(17) Bird Notes from the Upper Peninsula.—E. E. Brewster, Iron Mountain.
*(18) The Damage done to Young Trees by Deer and Elk.—W. J. Beal, Ph. D.
*(19) The Scale Insects (Coccidae) of Michigan.—R. H. Pettit, Agricultural College, Illustrated with lantern slides.
(20) Observations on *Hydra.*—H. H. Parke, Ann Arbor.
(21) The Evolution of the Lithodidae.—S. J. Holmes, Ann Arbor.
(22) The Reactions of Infusoria to the Electric Current.—Raymond Pearl, Ann Arbor.
(23) Development of the Hypophysis of *Amia.*—S. O. Mast, Ann Arbor. With lantern slides.
(24) Bounties for Noxious Animals in Michigan.—Walter B. Barrows, Agricultural College.
(25) Studies of the Classification of Minnows.—William T. Shaw, Agricultural College.
*(26) A New Method for the Mechanical Analysis of Soils.—Prof. J. A. Jeffery, Agricultural College. With apparatus and demonstration.
(27) Syllabus for a Short Course on Grasses and other Forage Plants. W. J. Beal, Ph. D., Agricultural College.
(28) Some notes on the Advantage of Testing Seeds in Moist Air.—C. F. Wheeler. Agricultural College.
(29) Distribution of the Prickly Pear, *Opuntia Humifusa Raf.*, in Michigan.—C. F. Wheeler, Agricultural College.
(30) Some Observations on the Habits of the Harlequin Snake, *Elaps fulvus*, and Water Moccasin, *Agkistrodon piscivorus*, in Confinement. (By title.)—Percy S. Selous, Greenville.
(31) Pure Milk Supply.—Charles E. Marshall, Agricultural College.
(32) The Coleoptera of Northern Michigan.—E. A. Schwarz, Washington, D. C. (Read by title.)

SCIENTIFIC USES FOR MICHIGAN FOLK-LORE.

BY HARLAN I. SMITH.

The Indian tribes of Michigan have a considerable literature, consisting of legends and myths which, since they had no written language, have been preserved by frequent repetition. As literature, these are not of the highest type, although probably better than is generally supposed. The scientific use of this material is not necessarily impaired by its lack of literary merit.

The following tale which is an example of this folk-lore was collected in October, 1894, at Peonagowink, an Ojibwa Indian community, situated on the west side of the Flint river in Saginaw county, Michigan. It was told in broken English by an old Shaman, now an exhorter in the Indian Methodist church:

My ancestors told me that at one time eleven Ojibwas went on the warpath beyond the Rocky mountains. Their leader, when a young man, had been painted with black coal and, with other young men, had fasted from ten to twenty days, until they began to dream of what to do in life when they went to war. If a war party would be successful it should take the exact number of men indicated by the dream. This man had not been in the habit of dreaming. He led his party westward, fulfilling all the directions he had received in his dream until on a mountain they saw a nest surrounded by water, like an island. There they saw two birds as white as snow, which their leader told them not to harm. One of the party, lingering in the rear, foolishly attempted to shoot the birds with his bow and an arrow. Whenever he aimed at one of the birds it winked and the arrow was split by a slight stroke of lightning accompanied by a little thunder. The party went on. They saw black clouds gathering in the east and heard heavy thunder. The leader told his men to separate and stand under the large trees. The thunder approached rapidly and became terrific. The man who had attempted to shoot the birds was struck by lightning which left only his skin. The party was frightened and feared that they would be punished because that member of their party had done wrong in trying to kill the birds. The leader was successful in obtaining some scalps and returning home, at which time they had a dance.

This tale is a curious combination of mythological and legendary characters and also contains unmistakable references to puberty rites. The narrator, although an old man, could not explain the story, which like all folk-lore preserves ideas and traces of philosophy long forgotten by his people.

The references to the thunder bird, the painting of the face and fasting when young, show that the same influence was present with his people as with people even as far west as British Columbia. There is folk-lore evidence showing a continuous line of influence transferred from tribe to tribe from the mouth of the St. Lawrence to the head waters of the Columbia. Michigan folk-lore is one of the links in this chain.

The puberty rites illustrate the fact that religion and philosophy may be reconstructed to a certain extent, from survivals in the tales told by people who have long since failed to understand their import.

To a certain extent the earlier ethnological customs are recorded in these homely tales. In this case we have a clue to the great distance war parties traveled, the method of painting and fasting, a knowledge that the bow and arrow were carried by war parties, the taking of scalps, the social organization under a leader, and the dance.

The narrator of this story did not believe it, although he did when young. His son does not know it, his grandchildren probably have never heard it. The two latter generations talk English. This is practically the case with all of the Indians of Michigan. When these old Indians die this mass of literature and its possibilities become extinct. Bibles and song books have been printed in which Indian words have been substituted for English, but we can hardly say that, of the literature of the several Indian languages of Michigan, any has been recorded in the State for future study.

The development of the State has been so rapid that these matters have been overlooked. There are yet a few old men living who can relate such material. A record of it by phonetic symbols retaining the original Indian is most desirable for the uses above suggested. The imminent danger of the entire loss of the material, however, pleads that it be recorded in any manner, however imperfect or fragmentary. The Indian who keenly feels that his race is doomed to extinction likes to leave such records behind him and may be easily persuaded in the matter.

THE PREHISTORIC ETHNOLOGY OF THE THOMPSON RIVER REGION.

BY HARLAN I. SMITH.

My archaeological explorations, for the Jesup North Pacific Expedition in the Thompson River region, were carried on from Lytton at the junction of the Thompson with the Frazer River, to Kamloops at the union of the north and south branches of the Thompson as well as in the tributary Nicola Valley as far eastward as the head of Nicola Lake. The work was done in 1897 supplemented by visits in 1898-99.

The streams of this region have cut small mountains out of the rolling plateau which extends from the Coast Range to the western slope of the Rocky Mountains. The climate is dry and consequently vegetation is scanty except along the streams. Deer and elk in great numbers formerly grazed on the hills among the open timber. Salmon ascend the streams from the Pacific to spawn. There was however insufficient quantities of any few staple products to enable a people to live without resorting to the many resources of the country. In this respect the early people of this region were less fortunate than those of the coast who had such immense quantities of cedar, seals, salmon and shell-fish that they required little of other products.

The archaeological literature of this region, until visited by this expedition, was largely confined to pages 10-12 of notes on the Shuswap people of British Columbia by Dr. George M. Dawson in the Transactions of the Royal Society of Canada, Sect. 2, 1891. There were a few specimens in the Provincial Museum at Victoria and the Geological Museum at Ottawa, practically all other data being unavailable because unpublished or in private cabinets.

The archaeological specimens were found in ancient village sites but largely in graves, some of which were in the ground, others formed by causing talus material to slide down over the bodies placed on the ground at the foot of a bluff. The skeletons were usually found buried upon the side, and always flexed. They were sometimes covered with fragments of matting and fabric made of the sagebrush bark which had been preserved by the dryness of the climate.

The greatest antiquity which can be assigned to these remains is best judged by the fact that some of the graves were not known to exist by the natives and were not mentioned in their traditions. Objects obtained from the whites were not found in these graves.

Circular holes from ten to about thirty feet in diameter by two to five feet deep, surrounded by an embankment, indicate that the ancient winter houses were identical in type with the underground houses used by the natives of the region in historic times and of which two examples still exist, although fast going to ruin. Saucer shaped depressions indicate the sites of summer lodges, also similar to those of which one or two may still be seen in out of the way places. These are the typical conical tepes of the plains and ally the culture of this region with that further east.

The implements used in procuring food were chipped points of stone for arrows, spears, etc., points rubbed out of slate and bone, and antler implements for killing bear. Roots were dug as indicated by the crutch-like handles made of antler for digging sticks. Scrapers for securing the edible inner bark of various pine trees, and bone tubes like those used for drinking water by modern Indian maidens during puberty rites, were also found. For the preparation of food stone pestles, anvils, mortars, and fish knives made of slate like those still used on the coast were secured.

For building houses and carpenter work wedges made of elk antler, stone hammers, nephrite adzes or chisels which may also have been used for battle axes, whetstones, carving knives made of beaver teeth, and chipped stone scrapers and drills were found. Pairs of coarse sandstone semi-cylinders grooved in the middle of the flat sides, similar to the modern arrow shaft smoother, bone awls, skin scrapers, and flat needles such as are now used for sewing cattail stalks into mats, with which to cover the houses, were frequently secured.

For war, besides the objects which were used for procuring game for food, there were found war clubs made from the ribs of whales. The handles were carved to represent human heads and the sculpture resembles that of the coast, from which the bone must have been imported. There were also bone daggers.

For dress, skins of deer and birds as well as fabrics woven of vegetable fibre were used, as is testified by fragments preserved by the dry climate. Red and yellow ochre and blue paint for decorating the body, head scratchers, hair ornaments, nose bars and ear pendants, were used for adornment, as well as copper, bone and shell beads and the perforated teeth and claws of animals. Irridescent abalone shells of the coast had been imported and made into ornaments.

For gambling dice similar to those still made of the beaver teeth, and tubes resembling the modern gambling implements of the region were found. Large pecten shells perforated like those used for rattles in the dances of the coast, had penetrated to this inland region. The pipes were made of steatite, of the shape of a wine glass, and were decorated by incised designs which the modern Indians interpret as representing guardian spirits. These tubular pipes and the stone mortars resemble those found to the southward as far as California.

The art of the people, although most characteristically shown by the engraved designs on the pipes and digging stick handles, reached its excellence in the sculptured war clubs, which most nearly resembles coast art.

The prehistoric culture of this region resembles that of the present natives, some of whom still use stone implements. The present pipe, however, is not tubular but crooked like the elbow of a stovepipe. The recent arrow point is smaller, and the modern Indian believes the large ones were made in a mythical period before the time of man. Although these changes have come, yet the Indians can still explain the old incised designs. There is found evidence of only one culture and type in this region.

The dependence on many resources instead of relying upon a few, the circular form of the lodge, the arrow shaft smoothers, incised designs, chipped points and practice of burying the dead in isolated graves or in small cemeteries show affiliations to the plains. The tubular pipe and stone mortar show contact with the culture of California and the interior of Oregon. These affiliations differentiate the culture from that of the coast, but the sea shells, bone of the whale, beaver teeth dice, rubbed slate points and fish knives, and the sculpture shows contact with the coast culture. The flexed position of the skeletons in the graves resembles the posture of those found in the graves of the Lillooet valley, the shell heaps of the Frazer delta, and the cairns of southeastern Vancouver island. As on the coast the potter's art was not practiced nor has a single specimen of it been found in the entire region. On the whole the culture must be classed with that of the plains rather than with that of the northwest coast.

ASEXUAL DIMORPHISM AND THE ORIGIN OF SEX.

CHARLES E. BARR, ALBION.

For a number of years the problem of sex has engaged my attention and from the clash of opinion engendered in class-room discussion, a theory has arisen that, though as yet incomplete, seems worthy of record. I believe that it offers a more rational, as it certainly assumes a more fundamental conception of sexual differentiation than has yet been promulgated.

To those who may feel that it goes too far, that it reaches into the too remote past, I can only say that the failure of those who have before attacked the problem seems to me due to this very thing, that their search has not been pushed far enough. Surface truths must be rigorously investigated and the clues that they afford traced to their limit before we may be satisfied.

The far-reaching assumptions of the first section may seem to some too bold, to others foolhardy, to others destructive of what they have considered the highest and best. For them no apology will be offered. They have been pondered well and, if they be carefully followed out, will be found thoroughly consistent with the spirit of modern scientific research as well as with those truths that are so firmly established that no shock of impact can ever shake them. I refer to the ideas of God as creator and as imminent in all his works.

That there are profound differences between the female and the male organisms, apart from mere morphology, cannot be doubted. Just what these differences are and just what their significance, has been the subject of much dispute. It may well be said that no hard and fast line can be drawn, that they so intergrade in their manifestations that each often presents characteristics typical of the other. A large body of evidence has been accumulated upon which a general contrast may be established; but, so far as I am aware, no satisfactory basis for this fundamental difference has been suggested. Such a basis I hope to establish.

The contrast referred to is, in brief, this—the male is, on the whole, predominatingly active or katabolic, the female preponderatingly passive or anabolic.

The same phenomenon may be observed in that which essentially establishes the sex of animal or plant, the reproductive elements:—on the one hand the active, motile spermatozoon or spermatozoid, on the other the passive or sluggish ovum or ovule. In the light of these facts we may well believe that the evolutionary origin of sex elements affords a question fundamental to the consideration of later problems.

As phenomena whose nature clearly foreshadows sexuality are exhibited even in the protozoa, it is evident that if we wish our search to be fundamental we must look even beyond these for its beginnings.

The logic of evolution, the principle of continuity, demands that the organic be conceived as arising from the inorganic. Through the action

of energy, as of simple heat, combination occurred. From the simple arose the slightly complex. From complex to more complex we pass as new combinations of energy act, until at length we reach the acme of complexity—that substance supremely complex, hence supremely unstable, that substance that gains only to lose and loses in the act of gaining, protoplasm. Not protoplasm as we know it today, for protoplasm has become profoundly modified, but protoplasm *simplex*, the actually simple substance organized by physical and chemical forces alone, but structureless in the sense that it is homogeneous throughout, only of enormously intricate molecular organization. This simple protoplasm, through the aid of forces from without plus the energies gained by its internal changes, assimilates and grows. As it increases in bulk its gain in surface lags behind its increase in volume. But assimilation must occur through the surface, unless assimilation occur it must break down and lapse into the inorganic again. The surface, then must increase; perhaps by thinning out as into a sheet, but surface tension tends to bring it to the spherical form and it can and does best effect the end by division into a number of parts—two, three or any number of them. Note well that this is the result of unfavorable nutritive conditions.

We are accustomed to think of sexuality as the highest development of the living thing, as occurring at the maturity of an organism, at its limit of growth, when those forces that have built it up are no longer able to increase its size. But sexuality rests back on reproduction and we here trace reproduction to its limit and find the same thing characterizing it that has inhered in all subsequent development.

Now the evolution of the cell and its elements occurs, the origin of organism. A rapid sketch must suffice:—stimulus at any point produces reaction of the whole—stimulus paths occur throughout the mass, the outside responds to stimulus directly, the inside indirectly—in the interior the results of varied stimuli first encounter each other and are composed into a resultant effect—coordination arises—a nucleus is born—reactions become stored as experience—specialized portions representing a physical cell-memory are produced—by the aggregation of these is formed the heredity apparatus, chromomeres and chromosomes—a cell-memory for division arises, though it seems not to have been fully localized, in all cases, in a centrosome, etc., etc.

Division, the result of food-scarcity, is reproduction. To preserve itself in unfavorable conditions binary and multiple divisions are sifted out by natural selection. Other things being equal, size is an advantage. By binary division the greatest size of the resultant cells is gained, together with a moderate increase of surface and nutritive power. In multiple division the bulk is indeed less, but there is relatively very great gain in surface, hence great nutritive power and great potential activity. Little food is needed to nourish so small a body, but it has great ability of gaining it. In this case we have, then, instead of a starved, a better provided organism. Thus arises reproductive, though not yet sexual, dimorphism. Let us for a moment consider reproduction as it obtains among the lower forms today.

In Vorticella fertilization is often attained by the breaking up of an individual into a number of smaller cells that swim off, and, seeking a

fixed individual, fuse with it. This is conjugation, but conjugation is, in effect, a sexual process and we have here the analogues, at least, of sexual elements, in which the sedentary individual represents the ovum and the free one the sperm.

In the gregarines we have an asexual multiplication that is exceedingly suggestive. In these, as well as in other forms, reproduction may consist in splitting up the body into a multitude of individuals. This obviously secures a greater number of chances in the lottery of life. In other forms, the entire protoplasm grows fat, rounds up and secretes a thick covering that may protect it during the time when the growth-rythm, from external causes, must be suspended. Thus, on the other hand, is increased the individual chance in the same struggle for existence.

We have here, then, two forms of asexual reproduction, each affording essential characters of sex-cells. Let us examine them further. In Volvox, *under unfavorable conditions*, both methods may occur, though union between the two is today necessary for continued existence. Did not these two methods originate as a means of tiding over, asexually, an unfavorable time by embracing both the possibilities indicated above? Some individuals of the colony are nourished at the expense of the rest that they may be strong to resist. Others are broken into minute, flagellated individuals that they may, by their dispersion, find an environment where, with the lesser demand of their smaller body, they may eke out a miserable existence. If, however, asexual dimorphism has ever thus obtained in Volvox it has ceased to do so today for sexual union has come to be the necessary rule; and yet a careful comparison of the individual cells of a single hermaphrodite colony seems to afford ground for suspicion, at least, that the view above suggested may be essentially a true one.

(A.) A single zooid, poorly nourished, divides into many actively motile cells that become male or fertilizing cells.

(B.) A single zooid separates from the colonial complex and by ordinary repeated division forms a colony asexually.

(C.) A single zooid, better nourished at the expense of its neighbors, grows into a large, sluggish or passive cell, the ovum or female cell.

The second type (B) intermediate in size and activity, may well represent both extremes, preserving the original method of growth, while the colony calls into use the others, involving specialized germ-cells, only when it must otherwise fail to secure perpetuity.

Certain phenomena in the reproductive processes of Amœba are very suggestive here. Spore formation and the condition of encystment may well represent the methods just discussed, though it has never, so far as I am aware, been suggested that this has any sexual significance. Of course this is not sexual differentiation; we simply have the condition that has been overpassed by others, as perhaps Volvox, in true sexual evolution. Does it not, however, suggest the primitive potentiality of their so developing before the habit of union had become fixed?

Reproduction as it exists in the metazoa has been of slow growth. Arising in the protozoa from equal binary fission, smaller buds were next set adrift. In turn, certain individuals in a somewhat integrated colony were specialized for this purpose and ultimately groups of cells

in a "body" were thus freed, this leading to true sexuality as exhibited in dimorphic sex-cells that by their union give rise to a fertilized egg.

While the struggle for existence, as just indicated, may well have been the active stimulus to asexual dimorphism and thus to sexual differentiation, there are other reasons that appear even more cogent.

If bulk is advantageous unequal binary division will favor the larger resultant cells. Unequal division will normally occur through variation, or, in a cell containing metaplasm a smaller cell will be cut off at the upper pole. Natural selection will then favor the larger cell and greater and greater inequality will result until the lesser half represents a polar body only. It should be noted that this polar body is not comparable to the cell produced by multicellular division. In each case an equal distribution of the nucleus occurs, be it into two or many parts, but the cytoplasm in the case of the egg division is nearly all retained in one.

It should be said that before this the diverse reproductive capabilities referred to have arisen, part instead of half the body being set free in reproduction, metazoa have become established and the reproductive differentiated from the somatic cells.

As a result of the very unequal division described, the larger cell will be left with little free energizing power for it has gained but infinitesimal excess of surface and has lost a portion of the metabolizing nucleus. It is in the best possible condition for maintaining its life processes at a very low ebb until a season of abundance comes to it again. By a subsequent process, however, the extrusion of the second polar body with half its nuclear machinery (which see later) and the tachygenetic change which followed, it has evolved to its own destruction unless some outside power endow it.

On the other hand, the minute cell, the product of multiple division, is active, superabundantly vital and needs but to obtain food to grow and develop into a new organism.

Could, then, the passive "ovum" of a Volvox ever have maintained itself, tiding over, in its hibernation state, the rough places in its experience and completing its development as favorable conditions arose again? Perhaps, but it must have been at a serious disadvantage as compared with what, by a step further, it has gained.

Could the smaller, motile "spermatozoon" maintain itself by finding new and congenial surroundings? Possibly, but it must have been grievously handicapped by its lesser variability, at least. If, however, the two, by combining their forces could secure both the desirable ends of variability and abundant nutrition how satisfactory the outcome!

It has been demonstrated (Boveri* and Delage†) that the essential act in fertilization is the union of the spermatozoon with the ovulary cytoplasm. The union of the germ-nuclei is a secondary phenomenon.

What, however, has caused the spermatozoon to seek and enter the ovum? It is significant that the sperm nucleus, as soon as it enters the egg, begins to grow, and, as we see, at present, continues to do so until it reaches a size equivalent to that of the ovular nucleus itself. The egg seems, as is but natural, to furnish a pabulum for it that is exactly

* Sitz d. Gesellschaft für Morphologie und Physiologie zur München. Sitzung am 16 Juli, 1899.

† Comptes Rendus, cxxvii, 528-531.

adapted to its use. Must we not, then, believe that the so called "sexual attraction" between sperm and egg is the seeking by the former of that which enables it to continue its existence—that it is a phenomenon of the search for subsistence—an attraction chemical, physical or mechanical toward that which it must have to supply material upon which its katabolic tendencies may work?

The smaller cell, then, seeks the larger, enters it, feeds upon it, grows and possesses itself of the developmental machinery therein (energizes it, if you please) and proceeds to build up a "body." What is it then, that develops—the ovum or the sperm?

The value of sexual as compared to asexual reproduction does not admit of debate. On many counts cross-fertilization, which were impossible without union of the germ-nuclei, is a benefit. Evidence on this point is overwhelming. Propagation without amphimixis, at least under a variable environment, is not a success. Sexuality, by combining the germ-plasms from individuals of different experiences, widens variation, and the power of variation, and adapts to a wider environment.

Fundamentally the sperm is not alone the energizing, it is the actual being that continues the race. The ovum is primarily but the bricks and mortar, as it were, that the sperm, the builder, employs in the construction of the house.

Coming, however, into such relation to this cell as to employ its machinery it necessarily is brought to the center and thus to the nucleus of the egg. Entangling this in its meshes, the female pro-nucleus is perforce incorporated in the plan. But the mechanism is not adapted to the utilization of so many chromosomes. There are twice as many as can be utilized by the ovular machinery. The remainder are therefore set aside, and, as only impedimenta in subsequent processes, are cast out as a second polar corpuscle. That this reducing division in both egg and sperm later occurs, by tachygenesis, before fertilization is but an added safeguard to assure perfect cross-fertilization; for only thus can there be certainty of equal representation or, indeed, of one parent being at all represented in fertilization.

Parthenogenesis need not be considered a serious infringement of the usual law. To be sure it does not secure amphimixis but the data point to an auto-fertilization and whether the second polar body is extruded and then reenters the egg or is retained throughout is a matter of mere developmental detail. That the egg may develop without exterior fertilization need surprise none though Loeb's* experimental proof is indeed a brilliant piece of work. That it will do so if only proper stimulus be afforded is a necessary consequence of the theory here presented.

Summary:—

We are led, then, to believe:

First, Reproduction (cell-division) arose from unfavorable nutritive conditions, i. e., at the limit of growth.

Second, In the struggle for existence large and small cells arose (asexual dimorphism) to meet its exigencies in two ways.

Third, The ovum and the first polar body are simply the result of an unequal division.

* Amer. Jour. Physiol., Oct., 1899.

Fourth, Simple fertilization arose out of the search for food.

Fifth, The spermatozoon rather than the ovum must be considered primarily important in development.

Sixth, The union of the pronuclei is a mechanical necessity and as a result the second polar body (reducing division) is eliminated as a waste product.

Albion College, January, 1900.

SOME OF THE UNSOLVED PROBLEMS IN MICHIGAN FORESTRY.

W. J. BEAL, PH. D., AGRICULTURAL COLLEGE.

In June, 1887, one thousand dollars was placed by the Legislature at the disposal of a State Forestry Commission which made some observations, held one convention, and published one report. After four years the act was repealed. Since that time the interest in forestry has increased as the timber rapidly disappeared.

The Legislature of 1899, passed an act to create a second commission to canvass the subject and recommend legislation in 1901. In the minds of most people, there is a vague notion that something should be done, but what to do is not clear. A very small number believe it best to leave the subject, as in the past, entirely to the people in each locality to do as they please.

In the report of the State Horticultural Society for 1898, I presented a paper recommending twenty-five things as already established regarding the management of forests. At this time and in this place it seems eminently suitable to mention about seventy-five things that should be investigated, or concerning which, careful experiments should be made in the interest of the forests.

There are so many things to be learned, and trees need so much time to mature, that it is time we were at the subject with energy and financial support.

It took Germany one hundred years to prove that our white pine was an excellent tree for producing timber in that country.

In November 1887, when B. E. Fernow, then chief of the Forestry Department at Washington, was asked to name some of the things most necessary to do regarding the forests of Michigan, he replied, "On the whole, studies in the natural woods, observations seem to me more needed than experiments."

Here is an enumeration of some of the work that ought to be done in Michigan:

1. Have the harbors at the mouths of rivers needed more dredging since the trees were cut off along the margins of the streams?

2. Note the influence, if any, on different farm crops and orchards at different distances from forests of various degrees of density and height.

3. Observe the effects of spring and summer floods and mill-ponds on timber and note which kinds perish and which continue to thrive, with the view to learning what may be planted on such ground.

4. Note the effect of drainage of the land on forest trees.

5. Note the physical condition of the soil where excellent trees and where inferior trees of any promising species may be growing.

6. Study and experiment to learn which species of trees improve the soil most and which least.

7. Discover the reason why one mixture of trees sometimes changes abruptly for another growing near by.

8. Discover by experiments in removing all the litter from certain portions of a forest, every year, once in two years, three years, four years, or a portion of the litter every year.

9. Compare the litter and soil to the depth of one foot in a good forest with the soil of a field that has been cultivated thirty, forty, or fifty years or more.

10. Study the regions of sand-dunes and drifting sands in all places with reference to improvement.

11. Study the root systems of different sorts of trees growing under various conditions of soil and elevation.

12. Find out the geographical distribution in the State of any one or each kind of tree and the reasons therefor.

13. Note the distribution of the species in "second growth" on stump lands in many places, the kinds and the probable sources from "grubs or from seeds."

14. Make observations on the succession of forests to see if any further reasons can be discovered, as in case of pines, oaks, maples, etc.

15. Study the life history of any species, or all in Michigan, by noting its development from seed to maturity, as learned by studying at one time trees of all ages in the same forest.

16. What amount of wood by weight or bulk is built per year by a leaf surface of 1,000 square feet, of one to many species of trees, and the weight of the leaves in each case required to expose 1,000 square feet of surface.

17. How much is the surface of one to many species of trees reduced in winter compared with summer.

18. Study the rapidity of growth of each kind of desirable tree, each in large numbers, to learn the most favorable and most economical place and the least suitable place for growing each.

19. Compare some good maple trees of the same size growing on good land and on poor in the Upper Peninsula and in Lenawee county to learn which makes the most wood and which the best wood.

20. Compare the length of the growing season of one to many species of trees in the Upper Peninsula with the same in Lenawee county.

21. Compare the condition of large trees and of small ones as found standing in an old pasture with those growing in the woods. When opportunity offers, see about the rapidity of growth of trees since pasturing a wood lot.

22. Try to learn the conditions or various causes for a large annual growth or a small annual growth in any one or more trees of one or more species.

23. On a variety of acres, how many cubic feet of timber are produced in a year?

24. State all of our native trees and shrubs and grade them with reference to the relative amount of light they need or shade they will endure.

25. Experiment and observe to show that thin-foliaged trees should not be planted by themselves.

26. Which species of trees are least liable and which most liable to serious trouble from insects, fungi, wind, sleet, etc.?

27. Compare the economic value of good trees of different species, taking into account the rapidity of growth and freedom from insects and disease, and the value of the land on which they grow.

28. Secure seeds of every promising species from ten to twenty other states and test side by side with Michigan seed to learn where is the best place to secure seeds.

29. For a series of years, record the seasons when each species fruits abundantly, noting frosts in spring.

30. Note the ages of different species, as they begin to bear fruit and as they bear it in abundance, and those rarely fruiting with seasons for the latter.

31. Test the vitality of seeds and nuts buried in the soil at different depths.

32. Observe the modes and the distances of seed dispersed, and try to learn what becomes of all the nuts and seeds with many details.

33. Observe when each kind of seed begins to grow and follow up seedlings to see what becomes of them in certain specified areas.

34. Experiment on seedlings of various promising species to learn the most suitable size for transplanting.

35. Experiment on numerous methods for learning the best and most economical way for securing thrifty young white pines and Norway pines planted where they are needed for a forest.

36. Experiment to learn the proper distances for planting white pines.

37. Observe and experiment to learn the readiness with which some different species of trees reproduce trees from sprouts.

38. Try different methods of renewing a forest.

39. Try different methods of management in cultivation, in mulching and in leaving to nature.

40. Compare trees of all sorts that grow from sprouts with seeding of the same kinds, for vigor and health.

41. Experiment to see if it pays to thin trees, or lop off the tops of trees of poor quality as they grow about trees of desirable species.

42. Note the changes for some years, that take place in the neighboring young trees that surround the spot where one or more large trees have been removed.

43. It is estimated that twice as much timber is stolen as is destroyed by fire. This subject should be referred to an able committee of whom some should be lawyers, to devise the best modes of putting a stop to such work. This is the problem of first importance.

44. Enumerate the sources of danger from fires in the State.

45. Where are the fires most frequent and severe? In such neighborhoods try by working with the people to induce reform.

46. Work out the details as to origin, course, extent and damage of some one fire.

47. In some few places prepare open roads and burn every year to keep them clean, noting results.

48. Make a few experiments on removing or burning the rubbish where timber has been cut out, to show the cost,—to show whether it is feasible or utter folly.

49. Study the stunted, slow growing little woody plants as repeatedly killed above ground by fire; see their growth after all trees have been removed.

50. Experiment with the common locust in various places and under varying conditions to learn how to prevent the depredations of the borers.

51. Test chestnut trees for thrift in many places and under varying conditions.

52. Test any American trees not found in the State in several places and grown under various conditions to possibly find some that are profitable to grow in Michigan.

53. Experiment with perhaps thirty or more species and shrubs to learn which are best to use as nurse trees to shade the ground in a forest.

54. Observe trees that have vertical splits and their attempt to heal. What are such trees? Under what conditions are they most liable to split?

55. Find out what they are and compare trees that split at the forks or crotches; also what trees break most by snow and sleet.

56. Compare trees of any species of varying ages to note how rapidly they must usually grow to be liable to recover from injury.

57. Study and compare many trees, noting the successes and failures in repairing wounds from decaying limbs and other causes.

58. Seek to find the sources of all possible injury to all sorts of trees and the preventives. Why are there so few pine trees to any acre?

59. Compare the specific gravity of any kind of wood grown in different parts of the State on sand, clay, or rich loam.

60. Test the weight, strength and durability of wood taken from different parts of an oak or arbor-vitae.

61. Compare the length and size of fibres of any broad-leaved tree or tracheids of cone-bearing tree, at different ages or periods of growth.

62. Where land is to be cleared, estimate carefully how much timber of different grades occur to a certain measured area, and then see how it comes out.

63. Years of work can be profitably employed in comparing the structure of wood of different kinds at different ages, with the view of learning its physical peculiarities and adaptability for certain uses.

64. Compare the tops of fifty trees of any species that have grown in the open with each other, noting whether the shapes change as the trees become larger.

65. Compare trees of either species grown in the open with trees of the same species grown in the forest.

66. Note and record the easiest popular points for identifying each species of tree as seen in winter, as seen in summer.

67. Which species of trees hold their leaves on low branches in a dense forest; on which species are the lower limbs naked?

68. Observe for some years the kinds, thickness, shape, size of tops of young trees from two to ten feet high and much crowded to see about dying branches and dying trees.

69. Compare the appearance, external and internal of trees grown, north and south.

70. Study areas of oak openings, of "timbered land," and try to make out all points of difference and try to account for these differences.

71. Pass over an old forest and study it with reference to removing ripe trees and younger trees of slow growth or poor quality.

72. Note where one hundred to one thousand or more trees are growing in a forest and try to account for their distribution.

73. Knowing the nature of the soil for any acre or more, what are the kinds of timber and the quality, also the kinds of shrubs and herbs? What kind of roots have the perennial herbs for each kind of soil, as on hills, upland, river bottom, clay, sand, loam?

74. Note what trees seem to be dying at the top in several forests, and search for the reason.

75. What are all the sorts of trees and shrubs, surrounding a first-class tree and the soil and climate of the locality.

76. Compare a number of trees of a number of species found on the north slope, on the south, on the east, on the west. Are any species doing better on the north slope? on the south slope? and which species, if any, and the probable reasons?

77. Study the sizes and shapes and texture of leaves of white oak as found on lower limbs in the shade, in exposed places, also, note those at the top of the trees, and near the center of the top. The same for any number of other species. If duplicates are observed and compared, all the better.

78. In addition to any of the foregoing, it will be useful to study all the details possible in a large number of good places in a forest, i. e., in a good forest. Note, almost by diagrams the positions occupied by the leading trees of each species, their relative heights, and sizes, the nature of the undergrowth, the dead leaves, sticks, logs, every detail.

79. After much time in studying this many-sided question, begin to make plans for growing good timber to advantage, whether they are ever carried out or not.

SYLLABUS FOR A SHORT COURSE ON GRASSES AND OTHER FORAGE PLANTS.

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As all students of botany find these plants difficult, it is desirable to place the study in the junior or senior year of the college course. Previous to studying grasses, the members of the class are expected to have some knowledge of plant histology, physiology, and classification, also of insects and fungi, which are especially injurious to plants found in grazing lands. A study of meadow weeds is omitted in this connection, as that subject is placed in another part of the agricultural course.*

Not less than thirty lessons should be given, nearly half of which should consist of practice in the laboratory.

In case the subject is taught in winter, we exhibit fine, full-sized specimens of the leading plants nicely pressed and sewed fast to manila paper. We have large pieces of well washed turf of June grass, quack grass, Bermuda grass; sods of several fescues, orchard grass, timothy and others and a grass garden for use during the growing season. I insist that each student shall supply himself with small bottles, for which I supply thirty to fifty named species and varieties of grasses, clovers, and other forage plants. They are encouraged to prepare herbaria of a small number of fifteen species of the most prominent forage plants.

I place most stress on the careful study of about fifteen species, including their description in accurate terms, rather than on "glittering generalities," such as one not much of a botanist would be likely to give. I induce students to strive very hard that they may be able to identify for certain in various stages of growth a few kinds of grasses, which is more than can be said, even of some teachers of botany or agriculture.

This part of the work is the key to success in the future and leads to mental growth, without which mental stagnation is likely to follow in a few months.

As a preliminary test, every student is set to assorting and identifying each species found in mixed hay.

The Stem: Note the parts of in several grasses.

- a. Those below or on the surface of the ground, root-stocks.
- b. Those above the surface usually erect, branching, sterile shoots,
- c. Bunch grasses, clearly defined and illustrated, timothy, orchard grass, sheep's fescue,
- d. Turf grasses, June grass, quack grass, red top, Bermuda grass,
- e. The structure of the nodes and their behavior in case stems are bent down,
- f. The oldest part of an internode.

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* For a Syllabus on weeds, see the Proceedings of the Detroit meeting of the S. P. A. S. held 1897.

The Leaf:

a. The several parts,
b. The apparent use of the sheath,
c. The use of the ligule,
d. The mode of elongation of the blade and the advantage for pasturing,
e. The effect of much heat and light and dryness on the blade,
f. The effect of shade or moisture on the blade,
g. Bulliform cells, their structure, action and value to the plant,
h. How the blades open and close, of June grass, orchard grass, timothy, Indian corn, and of what use to the plant,
i. The structure of blades of sheep's fescue,
j. The twisting of the blades and what is the advantage.

The inflorescence of timothy, June grass, orchard grass; the spikelet studied and compared in detail in ten or more leading grasses that are valuable for pasture or meadow. Empty glumes, floral glumes, awns, paleae, their uses and morphology. See also Stipa, Sweet vernal grass, Avena sterilis. How to distinguish true grasses from plants of other families, as sedges and rushes.

The chemical composition of grasses as affected by moisture, drainage, soil, sun, and shade.

The difficulties of obtaining uniform and reliable data.

The relative value to man of plants of this family when compared with those in any other family.

The various uses for grasses.

The effects of over feeding native grazing lands, as in southern Africa, Nebraska, Wyoming, Texas, Colorado, and the various changes going on, with reasons therefor. State concisely the various points in favor of growing timothy; i. e., the good qualities of this grass. In contrast, name the defects. Give a brief history of its introduction and use, so far as known in various points of the world.

State concisely pro and con and the history of orchard grass, tall oat-grass, meadow fescue, awnless brome grass, June grass, fowl-meadow grass, red top, meadow fox-tail, perennial rye grass, Hungarian grass.

Why is there so little know in this country concerning these and other grasses?

What are best known and most used in the United States and some reasons?

What is the remedy for this ignorance and indifference?

Why are fifty-one or more kinds of grasses, clovers, and other plants found useful each for some meadows of Great Britain?

What guides us in selecting suitable kinds for any fields? Points like this: nature of soil, climate, time it is to remain, for pasture, meadow or both, for all grazing animals or for horses only, or sheep only.

Test for any purpose each grass separately to learn which are among the best, and use five to ten or more of these kinds on each field. Why so many instead of one of the best? Because they always yield considerable more than any one of the best, often fifty per cent more.

Name the leading annual forage crops. Name ten that are suitable for enduring two years on arable land. Name ten that are suitable for

enduring three years or more on arable land. Name five that are suitable for permanent meadow on wet land.

Provided only one sort of grass or clover seed is sown, what shall be the guide as to quantity per acre? Consider the various seasons of the year for sowing seed. Seeding grass with grain; reasons for and against. Seeding grass without a grain crop, reasons for and against, in different regions of country.

Sowing seeds on meadow or pasture to improve it.

Should land be kept permanently in grass or should grass come in rotation with other crops? Consider all the points in favor and against each practice for Michigan.

Pasture yields more nourishment than a meadow, but less in weight. Illustrate and explain.

The care of pastures and meadows; effects of close grazing.

What manures and fertilizers to apply; the amounts, season for applying; conflicting results.

The battle in the meadow.

All manures tend to drive out nearly all weeds by increasing the vigor of valuable herbage.

Drainage and irrigation improve the quantity and quality of grasses, at the expense of most weeds.

Cutting and curing hay; the season and methods.

Securing new grasses and other forage plants.

Great improvement by selection and crossing. Harvesting, threshing, curing, and cleaning seeds of grasses and clovers.

Plants for making a good lawn; kinds to use; methods of seeding.

The history of the use of red clover.

The extent and nature of the roots.

The flower and mode of fertilization.

Bumble bees a great help; results of experiments.

The sleep of the leaves and the object.

Testimony as to the value of clover for feeding; value as a fertilizer.

Clover as a weed exterminator, and reasons why.

Amount of seed to use.

Care of young plants.

Winter killing, cause and remedies.

Saving the seed.

The source of dark seeds and light seeds.

The great variation of red clover.

The model plant.

Mammoth clover compared with red, in structure of plant and special uses.

Alsike clover; its habits and uses.

White clover; its habits and uses.

Crimson clover; its habits and uses and defects.

Alfalfa; why not more successful in a moist climate; slow to start, a poor fighter.

The success of lupines, sainfoin, hairy vetches, peas, cow peas.

Special uses of rape.

THE BIOLOGICAL SCIENCES AND THE PEOPLE.

JACOB REIGHARD, ANN ARBOR.

(Address of the Retiring President.)

Like the American Association for the Advancement of Science (and other similar organizations), the Michigan Academy is an expression of the voluntary scientific activity of the people of the State, and depends for its continued usefulness on a rational interest and a helpful co-operation on the part of the people.

It has therefore occurred to me to inquire in what way the biological sciences, from whose adherents the Academy draws most of its membership, touch the people: what in the growth of these sciences makes toward and what away from a contributory interest on the part of the people. By contributory interest is meant that which aids in the upbuilding of the sciences by adding something of importance to their store of fact or theory. The question that is raised is then, not what benefit do the people receive from the biological sciences, for these are many in the practical and in the educational application of these sciences; the question is rather how many or how do the people benefit these sciences by aiding in their further growth.

I shall speak from the zoölogical standpoint, but what is true of zoölogy, is true, in this matter, in large measure, also of botany.

The question seems to be intimately associated with the recent history of zoölogy.

The year 1859 found zoölogists, the world over, working industriously and quietly at almost purely descriptive work. No more was expected of any zoölogist than that he should discover and record the wonders of nature as revealed in the animal kingdom, and that he should duly express his astonishment at the infinite wisdom shown by the creator in arranging all these details. Of attempts to get at the meaning of the details there were very few. The popular notion of the zoölogist's aim in life is expressed in a question that I remember to have heard asked in my student days, by a much respected professor of literature of his zoölogical colleague. "Well now what is that animal curious for?" In this year appeared Darwin's "Origin of Species." Its effect is thus graphically described by V. Graff in a recent lecture. "It came like a lightning flash in a period of quiet descriptive work, a period which had accustomed itself to consider the nature-philosophy ideas of the beginning of the century as absurd freaks of imagination, unproved and unprovable, a period which therefore clung anxiously to its foundation of facts. How the theory of natural selection put life into this dry describing, how it hurried the knife of the anatomist, and what a broad prospect it opened before the hitherto short sighted eye of the systematist! About the mummies of the species which, separated from one another by carefully formulated Latin diagnoses, filled the collections, there suddenly appeared the constricting noose of blood relationship. The petrified remains of extinct forms, hitherto shut out from the com-

munity of living beings, received flesh and blood and demanded to be included with the existing fauna and flora in a single great genealogical tree, representing the history of life on our earth."

Darwin's book brought essentially two contributions. In the first place it brought a mass of *evidence* in proof of the proposition that animals are related to one another by descent. The *idea* of a process of evolution is very old and Osborn has recently traced its history from the early Greeks to the time of Darwin. Darwin did not originate the idea, he established it by a mass of evidence and it has been ever since accepted.

In the second place Darwin contributed the theory of the origin of species by natural selection. This theory is so well known that it need not be restated here, but it may perhaps be pointed out that the theory does not attempt to account for the origin of the variations upon which it depends. It is a fact that these variations occur and Darwin's theory bases itself upon this fact. He spoke of such variations as fortuitous. Aside from certain correlations, variations seemed to Darwin to occur by chance, though he did not exclude the possibility of their being later found to be subject to law.

The idea that the multitude of animal forms had thus originated by a process of evolution, and that this process was governed by a simple law, affected the whole subsequent course of zoölogy.

Zoölogists soon came to accept not only evolution as a process, but natural selection as at least the chief explanation of the process. The zoölogists following Darwin made but little attempt to study the variations upon which the theory of natural selection based itself, or to determine the range of variations or their causes. Having decided that animals were related to one another, and having fixed the law governing the origin of the relationship, zoölogists began to turn their attention to a study of the degree of relationship. A mania seems to have become prevalent for the construction of a genealogical tree of the entire animal kingdom. The ultimate aim of zoölogists ten years ago, or even five years ago was animal genealogy, and such is still the aim of many working zoölogists. Paleontology, comparative anatomy and embryology were believed to furnish the means for unraveling animal genealogies.

All three of these lines of research have been pursued (from the phylogenetic standpoint) with great enthusiasm since 1859, and they are still being pursued; the results have, however, fallen far short of meeting anticipations. From the paleontological side it was evident from the first that many animals had left no recognizable fossil remains. In other cases the remains were so imperfect, so difficult of access and so few that nothing like a complete series could be hoped for. Paleontology has accomplished a great deal. Where it is available, it is without doubt the safest guide, perhaps the only safe guide in phylogenetic speculation. On the other hand it has not, and in the nature of its materials cannot lead to a realization of the zoölogist's dream of a phylogenetic millenium.

Comparative anatomy has been to a considerable extent neglected during the past thirty years. Among the invertebrates, where the research could be carried on by the rapid methods of modern microscopic

technique there has been more work, than among the larger vertebrates where it is necessary to use the tedious method of dissection. Among the anatomical research of the last quarter of a century there is a noticeable dearth of *monographic* work. In the earlier part of the century anatomists were not so much concerned with the discovery of relationships, they were content to work long on single animals, and there were thus produced anatomical monographs which have not since been surpassed in quality. With the advent of Darwinism came a feverish haste to detect relationships, and this resulted in a desire to compare large numbers of animals with one another. The time required to study the whole structure of a large series of animals was too great for the life time of one man. Much could, however, be accomplished by the comparison of a single organ through a large series of animals—and so the comparative anatomy of animals (monographic work) gave place to the comparative anatomy of organs.

A second characteristic of the comparative anatomy of this period has been its great reliance upon embryology. Its facts have been too often distorted to make them fit with the results of embryological work, and thus what should be the base of the pyramid has been made its apex.

Embryology was, however, the guiding star of the post-Darwinian workers. It seemed to offer by far the easiest and quickest solution of their problems. It soon developed a technique of great intricacy and of great accuracy, and it came to offer easy conquests to the ambitious investigator. Its faintest hints at relationship were accepted as of the utmost importance and were given the deepest meaning. Scarcely any zoölogical work was complete without its embryological side. But it soon became evident that the development of an animal could not be construed as a simple repetition of its ancestral history. The ancestral features were always more or less modified by features impressed upon the developing animal by its surroundings. The embryo was, so to speak, burdened by a double task. It not only repeated the history of its ancestor, but it had also to adapt itself to its own very different conditions. The development thus came to be considered as made up of two factors—those that were ancestral (phylogenetic) and those that were acquired by the embryo and peculiar to it (cænogenetic factors.) The record was thus said to be falsified and to pick out the true from the false became the difficult task of the embryologist. This was a task requiring great judgment and one concerning which individual observers were likely to differ greatly. If an observer started with a certain theory as to the ancestral history of an animal, all those factors in its development which did not accord with the theory, were apt to seem to him to be falsifications of the record. Another observer with the same facts before him, but working on a different theory, would discover that many of these so called falsifications were really ancestral features.

Another factor which has hampered embryology as a phylogenetic discipline has been the too frequent limitation of the investigation to a single organ. It is easier to investigate a single organ through a series of embryos than to investigate the entire structure of all the members of the series. We are able to judge correctly of the character of a man only when we know all the elements that make it up. And so

with a series of embryos, we must know the whole structure, not merely a part of it. Monographic work is here quite as necessary as in comparative anatomy.

Many illustrations might be given of the grotesque results reached in animal genealogy, principally through too great reliance on embryology. That investigators with the same facts before them may reach diametrically opposite conclusions is shown in the attempt to trace the ancestry of the vertebrates. No less than a dozen invertebrate groups have been announced from time to time as having furnished the vertebrate ancestor. The cœlenterates, the anelids, the nemertines, the crustacea, the spiders, Balanoglossus and the tunicates have all been candidates for this honor, and perhaps all deserve it equally.

With such results the zoölogical pendulum may be said to have reached, for the present, the limit of its excursion in the direction of phylogeny. It is now beginning to swing in another direction. Within the last five years, zoölogists have begun to see that phylogenetic speculations have been to a large extent fruitless of specific results. They cannot be undertaken to advantage until we have vastly widened our field of knowledge. Then too it is being realized that the construction of a phylogeny of animals is, after all, not a matter of the greatest consequence. So long as we know that animals are related to one another and so long as we are able to investigate the laws which have governed the establishment of that relationship, it does not so much matter just *what* the precise relationship may be.

Zoölogists are then turning in other directions. There seems to me to be chiefly four:

1. There is among those engaged in purely descriptive anatomy or embryology a tendency, not yet very pronounced, but yet growing, to return to the monographic method of working. This is a return to the methods of the beginning of the century and betokens a purpose to let speculation rest for a while, until more materials have accumulated upon which to base it.

2. There is a marked tendency to study *variations*. The first book on this subject has appeared within a few years, and has stimulated the production of many papers. The purpose of the workers in this field is to determine the nature and range of variation so as to gain a familiarity with the nature of the materials upon which natural selection acts. It may thus be possible, as Bateson points out, for the investigator of the future to say not "if such and such a variation should occur," but "since such and such a variation does occur." Students of variation hope also to discover some of the laws which determine the production of variations. It is believed that they are not, as Darwin thought, fortuitous, matters of chance, but that they are subject to well defined laws.

All phylogenetic speculation is based upon the idea of homology, but the study of variations has set our ideas of homology toppling and until these ideas are reconstructed we cannot hope for any final determination of animal relationships.

3. Toward a study of the effect of environment in inducing and modifying developmental processes. Experimental morphology, experimental zoölogy, experimental embryology, are new subdivisions of our subject which expresses this tendency. It is possible to subject de-

veloping animals to the influence of various factors of the environment in order to determine their effect. Developing eggs may be subjected to different temperatures, or to chemical solutions of different sorts and strengths or to the influence of electricity. In this way we may find what influence each of these factors has on development. Adult animals may be subject to similar changes of environment. The results of such researches are usually expressible by mathematical symbols, such as geometric curves or algebraic equations.

Such work is only in the beginning but it may ultimately lead to such an analysis of the environment as to enable us to assign to each of its factors its proper value as an element in organic development.

Experimental work is also being directed toward a determination of the internal factors of development, those which are resident in the animal itself and are not impressed upon it by the environment. The effect of the removal of portions of the developing egg, enables us to determine the part taken by those portions in the normal development of the whole egg. Others of the internal factors of development may be studied by direct observation (without experiment) and by comparison.

4. Toward a study of the activities of animals. Animals exhibit many sorts of activities that may be classified. Those connected with the taking of food, with reproduction, with the rearing of young, with construction of dwellings, with community life and so on. We are beginning to suspect that many of these activities have features that are common to large numbers of animals and that their origin and development may be traced with as much certainty as the origin and development of the organs of the animals. Many of the activities of man himself may doubtless be traced to an origin in the lower animals and much light thereby thrown on what we are pleased to call *human nature.*

Monographic work in its descriptive branches, the study of variation experimental work, and the study and comparison of the activities of animals seem then to be the directions in which zoölogical research is now turning.

The phylogenetic phase has passed the height of its development for the present and must await the accumulation of new data before it can again become dominant. But since the study of phylogeny does not really solve any philosophical question (but only gives form to a question already assumed to be solved) it is likely that it will never again become ascendant. Time will bring the solution of many of its problems, but such solutions are likely in the future to possess only secondary interest.

On the other hand the new lines of work look toward the solution of the most important questions concerning the *method* of origin of organic forms.

Coincident with the gradual acceptance of the evolution idea, and coincident with the great development of morphological and phylogenetic ideas in our universities, there seems to have been a decline in popular activity in natural history. This did not become manifest immediately after 1859, but began, perhaps, ten or fifteen years after that date and has been in progress since then, up very nearly to the present time.

The most striking evidence of this decline is afforded by the decay of natural history societies. In this State Detroit and Grand Rapids each formerly supported such societies. They were well patronized, had rooms of their own, held stated meetings, and accumulated collections. The Detroit society has long since decayed and its collections have passed into other hands. The people of Grand Rapids are so apathetic that there seems every reason to fear that they will permit the collections of the Kent County society to pass out of the city.

Many similar societies in other parts of the country have had like histories. A number of such are known to me.

This decline of popular interest has affected not so much the theories of natural history as its materials, not so much perhaps popular interest as popular participation. It has taken place by the side of an unprecedented activity in zoölogy in the universities and colleges and in the scientific work of the government.

May we not seek the explanation of it in two directions? First in the hostility or apathy of the church. So long as the study of natural history seemed merely to reveal the wonders of creation and to magnify the marvelous work of the creator, the church encouraged it. The evolution idea on the other hand was strongly combatted by the church. While it is, perhaps, not possible to trace the effect of this controversy on the popular interest in natural history, we may feel sure that a state of mind which looked upon every animal adaptation, as upon every visitation of disease, as an expression of divine wisdom, must have been more sympathetic toward the study of natural history, than one which saw in the animal only a vaguely comprehended end-result of an evolution process, itself subversive of accepted religious beliefs.

A further reason for the decline in popular interest may be sought in the lack of stimulus from above. The zoölogists of the universities and colleges had become morphologists. A few of them kept up an interest in systematic zoölogy, but for the most part they were engaged in the laboratory study of the anatomy and development of preserved animals. Existing animals, the *end-results of an evolution process* were to be grouped in accordance with their genealogical history. The activities of animals, their habits, habitats, distribution, their relations to their environment, their ecology in short—all these were thought to be of little consequence. Students sent out from the laboratories of these teachers were much more familiar with sections and dissections than with living, or even entire animals. Once removed from the laboratory with its equipment of apparatus such students were quite helpless.

They experienced in most cases great difficulty in finding again in the field the animals that had served their laboratory studies. These students are the persons from among whom the membership in natural history societies is recruited. They are the persons who stimulate, in any community, an interest in natural history studies. These young recruits were then without interest in the study of living animals in their natural environment, while the people were, as they will likely always be, without interest in the laboratory study of anatomy and development. That which interests the people is not the dead end-product, but the living, active animal, the activities of animals, what they do and why they do it.

The people at large care but little about the structure even of man; they will know only what is necessary to care for the machine, and most of that they leave to the doctors. To know the origin of the various structures of man does not greatly interest them. How overwhelming on the other hand is their interest in man's *activities*. No other human interest transcends it.

But just as the structure of man has had a history: just as we may trace the development of his heart or brain through various stages which exist in the lower animals, so have the activities of man also had a history. The germs of his doings are to be found, perhaps all of them, among the lower animals. The social instinct, the home-building instinct, the instinct to care for the young, and how many others do we find in the lower animals. That these activities of the lower animals have given rise to those of man there seems little room to doubt. Just as the structure of man must be viewed against a background formed of the structures of lower animals, in order that it may be understood, so must man's activities be viewed against the background formed of the activities of lower animals.

Zoölogists are only slowly coming to realize this fact, and in the study of variation and its causes, in the study of the relation between the animal and its environment, in the study of ecology, or experimental zoölogy, we see evidence of this realization.

In this movement, indeed, the popular interest and the popular wisdom find their justification. In so far as zoölogy affords an explanation of the origin of human activities, it becomes important in the conduct of life, in so far it justifies itself in the eyes of the people. Zoölogy is now passing rapidly out of the ultra morphological and ultra systematic phase, into a phase where it will concern itself more with the activities of living animals and with the relation of these to the environment.

In these matters it will again appeal to the popular interest. Students from our colleges and universities when they have quitted the laboratory will no longer feel themselves strangers to nature. When they go among the people they will stimulate the study of a rational natural history.

From this cause and from the final lapse of the now nearly extinct opposition of the church we may expect a popular revival of interest in natural history subjects. Indeed, the introduction of nature study into our schools, the increasing number of popular books and magazine articles on natural history indicate that this revival is already at hand.

In the days before Darwin natural history societies contributed no inconsiderable part to the advancement of the sciences of zoölogy and botany. This they did through their collections and through the discovery by their members of new species, new localities and hitherto unknown habits of animals. May not the revival of popular interest which seems to be at hand again contribute to the advance of zoölogy? Observations on the daily life of animals, on their distribution and variations, on related subjects, may be made without the elaborate equipment of laboratory and library that is necessary for morphological work. Such observations are well possible to isolated members of a society like this one, and carefully made and well thought out, become real contributions to our science.

A CATALOGUE OF THE FLORA OF DETROIT.

O. A. FARWELL, DETROIT.

(Reprinted, with additions, from Eleventh Annual Report Commissioners of Parks and Boulevards, Detroit.)

My field work at Detroit has been extended over a series of eight years and has been confined for the most part to the eastern part of the city. In Detroit, as in most western cities with a territory of several miles in extent, there are several localities where the soil has not been turned by the ploughshare nor the forest disturbed by the woodman's ax. Such a place is that known as the Linden Park subdivision. It is a plat of land comprising several acres and lies east of the boulevard between Kercheval avenue on the south and Gratiot avenue on the north; at the northeast corner of this plat is situated the old race course and driving park, now overgrown with shrubbery, etc.

Belle Isle is an island at the head of Detroit river, about two miles long by one-half in width. The lower half has been largely cleared and improved for park purposes, but the upper half is still adorned with its virginal vegetable splendors. It is to Detroit what Coney Island, Central Park, etc., is to New York and is visited by thousands of pleasure seekers every day during the hot summer months. It is a part of the Detroit park system and in order to gather any of the wild plants that grow upon the island a permit from the Board of Park and Boulevard Commissioners is a *sine qua non;* I have been most fortunate in this respect, having been able, with but one exception, to obtain a permit each year. The greater part of the plants mentioned in this list have been collected from one or the other of these localities, but the grassy banks along the thinly populated streets, the ditches or gutters, and the ballast grounds have yielded some interesting things; also the wooded fields near Palmer Park (of the park system of Detroit) but this locality is outside of the city.

The character of the soil is much the same in all these places, it being a low, slightly undulating plain mainly of clayey composition. We will not therefore find a varied flora. In the canals, rivers, and ponds may be seen the water lilies, the millfoils, the potamogetons and the utricularias; the low marshy grounds give rise to the buttercups, lilies and sedges; while such plants as the St. John's Wort, compositæ and figworts are usually found growing on the drier grounds. In the River Rouge in the western part of the city may be found the rare American lotus, *Nelumbo lutea* (Willd.) Pers. This, however, I have been given to understand is not indigenous to this river but has probably been introduced from near Monroe. In Gray's Synoptical Flora the plant is said to be indigenous from Michigan and Minnesota to Texas and eastward. It has been said, however, that throughout the central states the plant is only an introduction, brought north by the Indians from farther south. *Potamogeton rutilus*, Mr. Wheeler informs me, was collected by himself in Detroit river just above Belle Isle but I have not as yet

seen it, it is a rare species in Michigan, having been found, I believe, in only one or two localities.

The ferns are few in number and each species is itself scarce; in the woods on Belle Isle may be found the *Dryopteris simulata*, recently separated from *D. Thelypteris* (Lin.) A. Gray by Mr. Davenport. It is a rare fern and more commonly met with in the eastern states. Michigan has not before been included in its range.

Some eastern plants have been creeping west; among these may be mentioned the *Cardamine hirsuta* Lin., the bitter cress; the *Geum vernum* (Raf.) T. & G. or spring avens; the *Physalis Philadelphica* Lam., one of the ground cherries; the *Euphorbia hirsuta* (Torr.) Wiegd., the hairy spurge; and a variety of chicory *Chicorium Intybus* Lin. *var. divaricata* DC. The *Cardamine* is rare in this country, being confined generally to the eastern Atlantic states, it is the first time, I believe, that it has been reported from west of the Appalachians. It was found in moist dense woods on the upper half of Belle Isle. The *Euphorbia* is another rare plant not before reported from west of New York; it has recently been separated from the *E. nutans* or *E. hypericifolia* which aggregate has given rise to several so called species. Another, the *Aster ericoides* L. var. *platyphyllus* T. & G. has crept up from the south; it is the first time it has been recorded for Michigan, and is quite common near the water works, on grassy banks. There is another peculiar form of aster which, perhaps, may turn out to be the rare *Aster amethystinus* Nutt. but it requires further study.

A rare and interesting find, as ballast waifs, were the Pacific coast *Lupinus polycarpus* Greene, *Trifolium furcatum* Lindl. and the *T. depauperatum* Desv. Among other ballast plants may be mentioned the Belladonna (*Atropa Belladonna* Lin.); the Ajowan (*Carum Copticum* (Lin.) Bth. & Hk.f.); and the common garden beet (*Beta vulgaris* Lin.) Probably a number of plants found on Belle Isle have been introduced by means of bouquets taken to the island by pleasure seekers and picnickers; as such, perhaps may be mentioned the American cowslip, (*Dodecatheon Meadia* Lin.), the Hellebore (*Helleborus viridis* Lin.), the Rattlebox (*Crotalaria sagittalis* Lin.), and the False Rue Anemone (*Isopyrum biternatum* (Raf.) T. & G.).

Several of our old and well known plants considered as single species by our older botanists have been split up into several by the younger botanists of the present generation. Whether or not these segregations are well taken can be told only by future field work and careful study. Among the old species so treated may be mentioned *Panicum dichotomum* Lin. which has been split into innumerable species of which we have three, the *P. Columbianum* Scribn., *P. pubescens* Lam., and *P. lanuginosa* Ell. *Agropyron repens* (L.) Beauv. has been divided and we now have in addition to the type the varieties *agreste* Anders. and *pilosum* Scribn. & Sm. and *A. Smithii* Rydb. *Sisyrinchium Bermudiana* Lin. has also been segregated and we now have *S. graminoides* Bicknell and *S. albidum* Raf. On the northeast corner of Belle Isle is an artificial lake constructed to reclaim a large tract of marshy ground. On the present site of the lake was discovered, several years ago, a peculiar *Sisyrinchium*. Instead of having flat winged stems and leaves as usual these were almost thread-like or terete; the bases of the leaves were

somewhat broadened and slightly hastate hence the name *S. hastile.* The construction of the lake mentioned above, I have no doubt, has destroyed the locality. Another species collected by the author near Birmingham has been named by Mr. Bicknell after the discoverer. I believe that several other new species from Michigan have been described as well as a score or more from other districts of the country. *Viola obliqua* Hill and *Viola sororia* Wild. have been eliminated from *V. cuculata* Ait.; *V. emarginata* (Nutt.) Le Conte and *V. ovata* Nutt. have been separated from *V. sagittata* Ait. The common plantain everlasting (*Antennaria plantaginifolium* (Lin.) Richards.) has been divided into a score or more species. Among those found at Detroit may be mentioned *A. neodioica* Greene *var. attenuata* Fernald; *A. neglecta* Greene; *A. occidentalis* Greene; and *A. arnoglossa* Greene *var. ambigens* Greene.

This list does not by any means represent a complete flora of Detroit, but only the results of such work as I have been enabled to do in the field. The sequence of families and nomenclature adopted in this list, except where the application of the rules of priority would require a change, are those exemplified in the Naturlichen Pflanzenfamilien of Engler and Prantl.

SUMMARY.

	Orders.	Families.	Genera.	Sp., Var. and forms.
Pteridophyta	2	4	6	13
Spermatophyta Angiospermæ Monocotyledones	7	16	77	241
Dicotyledones Choripetalæ	18	57	171	372
Gamopetalæ	7	26	117	259
Total	34	103	371	885

SUBKINGDOM 1. PTERIDOPHYTA.

ORDER 1. FILICALES.

FAMILY 1. OPHIOGLOSSACEÆ. Adders Tongue Family.

1. BOTRYCHIUM, Swz. Grape Ferns.
   1. obliquum, Muhl. Grassy fields at Linden Park. Rare.

FAMILY 2. OSMUNDACEÆ. Royal Fern Family.

2. OSMUNDA, Lin. Cinnamon Ferns.
   2. regalis, Lin. Royal Fern.
   3. cinnamomea, Lin. Cinnamon Fern.
   4. Claytonia, Lin.
   These three ferns are found on low ground at Linden Park.

FAMILY 3. POLYPODIACEÆ. Fern Family.

3. ONOCLEA, Lin.
   5. sensibilis, L. Sensitive Fern.
   Common in moist thickets on Belle Isle and main land.

4. DRYOPTERIS, Adans. Shield Ferns.
   6. Thelypteris (Lin.) A. Gray. More or less frequent on Belle Isle.
   7. simulata, Davenport. More or less frequent on Belle Isle.
   8. marginalis (Lin.) A. Gray. In woods at Linden Park. Rare.

5. ADIANTUM, Lin. Maiden-hair Fern.
   9. pedatum, Lin.
      Thickets on Belle Isle, more or less frequent.

ORDER 2. EQUISETALES.

FAMILY 4. EQUISETACEÆ. Horsetail Family.

6. EQUISETUM, Lin. Horsetails.
   10. arvense, Lin. Belle Isle, also main land. Common.
   11. pratense, Ehrh. Thickets on Belle Isle. Rare.
   12. fluviatile, Lin. Belle Isle, also main land. Common.
   13. variegatum, Schleich. Sandy shores of Belle Isle. Not common.

SUBKINGDOM 2. SPERMATOPHYTA.

CLASS ANGIOSPERMAE.

SUBCLASS 1. MONOCOTYLEDONES.

ORDER 1. PANDANALES.

FAMILY 1. TYPHACEÆ. Cat-tail Family.

1. TYPHA, Lin.
   1. latifolia, Lin. Cat-tail. Sandy grounds on Belle Isle. Rare.

FAMILY 2. SPARGANIACEÆ. Bur-reed Family.

2. SPARGANIUM, Lin.
   2. eurycarpum, Engelm. Marshy grounds on Belle Isle. Common.

ORDER 2. NAIADALES.

FAMILY 3. POTAMOGETONACEÆ. Pondweed Family.

3. POTAMOGETON, Lin.
   3. natans, Lin. Detroit River. Common.
   4. var. prolixus, Koch. Detroit River. Rare.
   5. alpinus, Balbis. Detroit River. Not common.
   6. gramineus, Lin.
      P. gramineus L. *var. graminifolius* Fries.
      Detroit River. The common form.
   7. var. heterophyllus (Schreb.) Fries.
      Detroit River, canals on Belle Isle. Not as common as the type.
   8. var. longipedunculatus (Merat.)
      P. heterophyllus var. longipedunculatus (Merat.) Morong, Mem. Tor. Bot. Club, 3, Pt. 2, 24: 1893. Detroit River. Common.
   9. perfoliatus, Lin. Detroit River. Common.
   10. var. Richardsonii, A. Bennett. Detroit River. Rare.
   11. compressus, Lin.
       P. zosteræfolius Schum. Detroit River. Common.
   12. mucronatus, Schrad. Detroit River; in shallow places near shore of main land. Common.
   13. filiformis, Pers. Sandy shores of Belle Isle, in shallow water. Rare.
   14. pectinatus, Lin. With the last, but common.

FAMILY 4. NAIADACEÆ. Naiad or Water Nymph Family.

4. NAIAS, Lin.
 15. flexilis (Willd.) Rosk & Schmidth.
  Either slender and distantly branched, a foot or more long, or short (two or three inches) and bushy, rigid. Common on sandy shores of Belle Isle in shallow places.

FAMILY 5. ALISMACEÆ. Water Plantain Family.

5. ALISMA, Lin.
 16. Plantago aquatica, Lin., var. trivialis (Ph.)
  A. trivialis Ph. Fl. Am. Sept. 1, 252: 1814.
  Leaves ovate or oval, large (5-6 inches long), obtuse, cordate, 7-9 nerved. 'The American plant differs from the European in having longer, more slender pedicles and in having smaller flowers, which are white instead of pale rose.
  Old race-course. Frequent.
 17. var. parviflora (Ph.)
  A. parviflora Ph. Fl. Am. Sept. 1, 253: 1814.
  Leaves and flowers smaller; leaves abrubtly acutish, 3-5 nerved, subcordate or obtuse at base. Vic. Linden Park. Frequent.

6. SAGITTARIA, Lin. Arrowhead.
 18. arifolia, Nutt. Belle Isle canals. Common.
 19. sagittæfolia, Lin., forma latifolia (Willd.) Britt. Belle Isle. Common.
 20. forma obtusa (Willd.) Britt. Belle Isle. Rare.
 21. forma hastata (Ph.) Britt. Belle Isle. Frequent.
 22. forma diversifolia (Engelm.) Britt. Belle Isle. Rare.
 23. forma augustifolia (Engelm.) Britt. Belle Isle. Rare.
 24. rigidia, Ph. In canals on Belle Isle. Common.
 25. var. Engelmanni.
  S. heterophylla var. augustifolia Engelm, in A. Gr. Man. Ed. 5, 494: 1867. Not *S. augustifolia*, Lindl. River shores of Belle Isle. Common.
 26. graminea, Mx. Shores of Belle Isle. Rare.

FAMILY 6. VALLISNERIACEÆ. Tape Grass Family.

7. VALLISNERIA, Lin. Tape Grass.
 27. spiralis, Lin. Eel Grass. Belle Isle canals. Frequent.
8. PHILOTRIA, Raf.
 28. Canadensis (Mx.) Britt. Water Thyme. Common in Detroit River.

ORDER 3. GRAMINALES.

FAMILY 7. GRAMINEÆ. Grass Family.

9. ANDROPOGON, Lin. Beard-grass.
 29. furcatus, Muhl. Linden Park. Rare.

10. CHRYSOPOGON, Trin.
 30. avenaceous (Mx.) Benth. Indian Grass. Linden Park. Rare.

11. SORGHUM, Moench. Broom corn.
 31. Sorghum (Lin.) Karst. Johnson-grass. Ballast grounds, Detroit. Frequent.

12. PASPALUM, Lin. Joint grass.
 32. setaceum, Mx. Linden Park. Common.

13. PANICUM, Lin. Panic Grass.
 33. sanguinale, Lin. Belle Isle. Common.
 34. humifusum (Pers.) Kunth. Belle Isle. Frequent.
 35. Crus-galli, Lin. Barnyard Grass. Belle Isle, etc. Frequent.
 36. var. mite, Ph. *Panicum Crus-galli* Lin. *var. muticum* Ell. Ballast Grounds, Detroit. Rare.
 37. var. purpureum, Ph. Belle Isle, waste places, etc.; the common form.
 38. var. Walteri (Ph.) *P. Walteri* Ph. Fl. Am. Sept. 1, 66: 1814. Low grounds near the water works. Frequent.
 39. sphærocarpon. Ell. Linden Park. Common.
 40. commutatum, Schultes. Waste places, Detroit. Rare.
 41. macrocarpon, Le Conte. Linden Park. Frequent.
 42. Scribnerianum, Nash. Linden Park. Common.
 43. pubescens, Lam. Belle Isle, etc. Frequent.
 44. lanuginosum, Ell. Grassy places under trees on Belle Isle. Frequent.
 45. Columbianum, Schribn. Belle Isle. Common.
 46. liniarifolium, Scribn. Detroit. Frequent.
 47. miliaceum, Lin. Millet. Ballast, etc. Detroit. Common.
 48. capillare, Lin. Belle Isle, etc. Common.

14. CHÆTOCHLOA, Scribn. Foxtail Millets.
 49. glauca (Lin.) Scribn. Belle Isle, etc. Common.
 50. viridis (Lin.) Scribn. Belle Isle. Common.
 51. Italica (Lin.) Scribn. Belle Isle. Rare.
 52. var. Germanica (Mill.) Scribn. *Panicum Germanicum* Mill. Gard. Dict., Ed. 8, No. 1, 1868. Ballast, etc., Detroit. Rare.

15. CENCHRUS, Lin. Bur Grass.
 53. tribuloides, Lin. Belle Isle, etc. Frequent.

16. ZIZANIA, Lin. Wild Rice.
 54. aquatica, Lin. Marshy grounds, etc., Belle Isle. Frequent.

17. HOMALOCENCHRUS, Mieg.
 55. Virginicus (Wild.) Britt. White Grass. Woods on Belle Isle. Common.
 56. oryzoides (Lin.) Poll. Rice Cut-grass. Borders of canals on Belle Isle. Rare.

18. PHALARIS, Lin.
 57. arundinacea, Lin., var. picta, Lin.
 The familiar ribbon grass of the garden is sometimes found in waste grounds.
 58. Canariensis, Lin. Canary Grass. Waste grounds, Detroit. Common.

19. MUHLENBERGIA, Schreb.
 59. Mexicana (Lin.) Trin. Near Palmer Park. Common.
 60. sylvatica, Torrey. Frequent on the south shore of Belle Isle.
 61. diffusa, Schreb. Woods on Belle Isle. Common.

20. PHLEUM, Lin.
 62. pratense, Lin. Timothy. Nimble Will. Woods on Belle Isle. Common.

21. ALOPECURUS, Lin. Foxtail.
 63. geniculatus, Lin., var. aristulatus (Mx.) Torr. Belle Isle shores, etc. Common.

22. SPOROBOLUS, R. Br.
 64. neglectus, Nash. Drop-seed Grass. Sandy grounds near the Water Works. Rare.
 65. cryptandrus (Torr) A. Gr. Rush Grass. Sandy shores at Detroit. Frequent.

23. CINNA, Lin. Reed Grass.
66. arundinacea, Lin. In woods on Belle Isle. Common.

24. AGROSTIS, Lin. Fiorin.
67. stolonifera, Lin.
A. capillaris Lin. Sp. Pl. 62: 1853, p. p.
A. vulgaris With. Belle Isle, etc. Common.
68. var. alba (Lin.) O. K. Belle Isle, etc. Common.
69. var. coarctata (Ehrh.) Celak.
A. coarctata Ehrh., ex. Hoffm. Deut. Fl., Ed. 2, Vol. 1. 37: 1800. Sides of gutters in Detroit. Rare.
70. pseudointermedia.
A. intermedia Scribn. Bull. Ten. Agri. Exp. Sta. 7, 76: 1894, not Balbis 1801. In vacant fields in Detroit. Common.
71. hyemalis (Walt.) B. S. P. Belle Isle. Frequent.

25. CALAMAGROSTIS, Adans.
72. Canadensis (Mx.) Beauv. Blue-joint grass. Low grounds on Belle Isle. Common.

26 AVENA, Lin.
73. sativa, Lin. Common Oat. Shores of Belle Isle, etc. Common.

27. DANTHONIA, DC. Oat Grass.
74. spicata (Lin.) Beauv. Near Linden Park, Detroit. Common.

28. SPARTINA, Schreb.
75. cynosuroides (L.) Willd. Marsh Grass. In woods on Belle Isle. Frequent.

29. ERAGROSTIS, Beauv.
76. Frankii, Steud. Sandy places on Belle Isle. Not frequent.
77. pilosa (Lin.) Beauv. Belle Isle. Frequent.
78. Purshii, Schrad. Belle Isle and other places at Detroit. Frequent.
79. major, Host. Belle Isle, etc. Common.
80. hypnoides (Lam.) B. S. P. Near Linden Park, Detroit. Frequent.

30. EATONIA, Raf.
81. Pennsylvanica (DC.) A. Gr. Belle Isle, etc. Common.

31. DACTYLIS, Lin.
82. glomerata, Lin. Orchard Grass. Belle Isle, etc. Common.

32. POA, Lin. Meadow Grass.
83. annua, Lin. Belle Isle, etc. Common.
84. compressa, Lin. Belle Isle, etc. Common.
85. pratensis, Lin. Kentucky Blue Grass. June Grass. Belle Isle, etc. Common.
86. flava, Lin. False Red-top. Belle Isle. Common.

33. PANICULARIA, Fabr. Manna Grass.
87. Canadensis (Mx.) O. K. Vic. Linden Park. Rare.
88. nervata (Willd.) O. K. Belle Isle. Common.
89. borealis, Nash. Belle Isle. Frequent.

34. FESTUCA, Lin. Fescue-grass.
90. elatior, Lin. Belle Isle. Frequent.
91. var. pratensis (Huds.) A. Gr. Various places in Detroit. Common.
92. nutans, Willd. In woods on Belle Isle. Frequent.

35. BROMUS, Lin.
- 93. ciliatus, Lin. Vic. Linden Park. Rare.
- 94. tectorum, Lin. Grassy sides of streets in Detroit. Frequent.
- 95. commutatus, Schrad.? Shores of Belle Isle. Rare.
  Cannot be B. racemosus to which this species is usually referred. Possibly it is B. arvensis; the spikes are softly pubescent.
- 96. hordeaceus, Lin. *B. mollis,* Lin. On sandy shores of Belle Isle. Rare.
- 97. secalinus, Lin. Belle Isle, etc. Common.
- 98. racemosus, Lin. Sandy shores of Belle Isle. Common.

36. LOLIUM, Lin. Ray or Rye Grass.
- 99. temulentum, Lin. Naturalized on Belle Isle, etc. Rare. Also cultivated.

37. AGROPYRON, J. Gærtn. Wheat Grass.
- 100. repens (Lin.) Beauv. Belle Isle. Frequent.
- 101. var. agreste, Anders. Grassy banks of streets in Detroit. Common.
- 102. var. nemorale, Anders. Waste grounds at Detroit. Common.
- 103. var. pilosum, Scrib. & Sm. Belle Isle, etc. Common.
- 104. forma stoloniferum. Spikelet not over 5-8 inch in length; empty glumes not more than a half the length of the spikelet; all the glumes cuspidate or with an awn equal to half their length. Culms rigidly erect, single; lower sheaths pubescent; leaves flat, smooth on the back, more or less scabrous or short strigose above. Grassy banks at Detroit. Frequent. No. 1634.
- 105. forma geniculatum. Spikes approaching those of A. Smithii; spikelets elongated, ¾ of an inch or more long, lowest remote, often an inch and a half apart, empty glumes cuspidate; flowering glumes acute, not awned. Culmes geniculate, cæspitose, forming mats 6 inches to a foot in diameter; leaves flat, scabrous above, smooth on the back; sheaths smooth equaling or exceeding the internodes. Sides of streets and ditches at Detroit. Frequent. No. 1635.
- 106. Smithii, Rydb. Waste places at Detroit. Common.
- 107. caninum (Lin.) R. & S. Near Palmer Park. Frequent.

38. TRITICUM, Lin. Wheat.
- 108. æstivum, Lin. *T. vulgare* Vill. Waste places at Detroit. Frequent.
- 109. var. hybernum (Lin.) *T. hybernum* Lin. Sp. Pl. 86:1753. The glumes awnless; common beardless wheat. Belle Isle. Frequent.

39. SECALE, Lin. Rye.
- 110. cereale, Lin. Frequent on Belle Isle and on waste grounds at Detroit.

40. HORDEUM, Lin. Barley.
- 111. jubatum, Lin. Squirrel-tail Grass. Waste places at Detroit. Frequent.

41. ELYMUS, Lin. Wild Rye.
- 112. striatus, Willd., var. villosus (Muhl.) A. Gr. Belle Isle. Frequent.
- 113. Virginicus, Lin. Belle Isle. Rare.
- 114. Canadensis, Lin. Belle Isle. Frequent.
- 115. var. glaucifolius (Willd.) Torr. Near old Race-course at Detroit. Rare.

42. HYSTRIX, Mœnch. Bottle-brush Grass.
- 116. Hystrix (Lin.) Millsp. In woods on Belle Isle. Common.

FAMILY 8. CYPERACEÆ. Sedge Family.

43. CYPERUS, Lin.
117. diandrus, Torr. Sandy shores of Belle Isle. Rare.
118. rivularis, Kunth. Sandy shores of Belle Isle, etc. Common.
119. esculentus, Lin., var. angustispicatus, Britt. Near Palmer Park. Not common.
120. strigosus, Lin. Belle Isle, etc. Common.
121. var. capitatus, Bœckl. Near Palmer Park. Not common.
122. var. robustior, Kunth. Belle Isle. Frequent.
123. filiculmis, Vahl. Near Linden Park. Rare.

44. ELEOCHARIS, R. Br. Spike Rush.
124. obtusa (Willd.) Schultes. Shores of Belle Isle. etc. Common.
125. palustris (L.) R. & S. Sandy shores on Belle Isle. Frequent.
126. var. glaucescens (Willd.) A. Gr. Belle Isle and elsewhere. Common.
127. acicularis (Lin.) R. & S. Shores of Belle Isle. Frequent.

45. SCIRPUS, Lin. Bulrush.
128. Americanus, Pers. Shores of Belle Isle. Common.
129. lacustris, Lin. Shores of Belle Isle. Common.
130. atrovirens, Muhl. Belle Isle and elsewhere. Common.
131. var. pallidus, Britt. Vic. Linden Park. Common.

46 ERIOPHORUM, Lin. Cotton Grass.
132. lineatus (Mx.) Bth. & Hk. f. Belle Isle, etc. Common.
133. cyperinum, Lin. Near Palmer Park. Frequent.
134. var. atrocinctus (Fernald.)
Scripus atrocinctus, Fernald in Pro. Am. Aca. Arts & Sci., Vol. 34, No. 19, 502:1899. Similar to the var. Eriophorum (Mx.) *Scirpus Eriophorum* Mx. Fl. 1, 33:1803, but the sheaths of the involucral bracts, the scales and the wool are from black to drab instead of rust-colored. The species has all the spikelets sessile in glomerules of three or more and the sheaths of the involucral bracts intermediate between those of the two varieties. The two varieties have the spikelets clustered, but the lateral or outer ones are on more or less elongated pedicels.

47. RYNCHOSPORA, Vahl. Beaked rush.
135. glomerata (Lin.) Vahl. Linden Park. Common.

48. CAREX, Lin. Sedge; Swamp grass.
136. intumescens, Rudge. In woods on Belle Isle. Common.
137. Asa-Grayi, Bailey. Low grassy grounds on Belle Isle. Frequent.
138. gigantea, Rudge. Tr. Lin. Soc. 7. 99. pl. 10. 2:1804. *Carex lupulina* Muhl. *var. peduntulata* Dew. Borders of woods on Belle Isle. Common.
139. var. lupulina (Muhl.) *Carex lupulina*, Muhl.; Willd., Sp. Pl. 4, 266:1805. In woods on Belle Isle. Common.
140. hystricina, Muhl., var. Cooleyi, Dew. Low grassy shores of Belle Isle. Rare.
141. Pseudo-Cyperus, Lin., var. Americana, Hochst. Marshy grounds on Belle Isle.
142. squarrosa, Lin. Woods near old race-course. Rare.
143. typhinoides, Schwein. Vic. Linden Park. Rare.
144. riparia, Curtis. Marshy grounds on Belle Isle. Frequent.
145. lanuginosa, Mx. Borders of canals on Belle Isle. Frequent.
146. filiformis, Lin. With the last but more common.
147. fusca, All. Near Linden Park. Frequent.
148. stricta, Lam. Shores of Belle Isle. Rare.
149. Haydeni, Dewey. Shores of Belle Isle. Rare.
150. gynandra, Schw. Linden Park. Frequent.
151. flacca, Schreb. *C. glauca* Scop. Southern shores of Belle Isle. Rare.

152. virescens, Muhl. Linden Park. Frequent.
153. gracillima, Schw. In woods on Belle Isle. Common.
154. grisea, Wahl. Borders of woods on Belle Isle. Frequent.
155. granularis, Muhl. Woods on Belle Isle. Common.
156. var. Shriveri, Britton. Vic. Linden Park. Frequent.
157. viridula, Mx. Shores of Belle Isle. Not common.
158. conoidea, Schk. Near Linden Park. Rare.
159. laxiflora, Lam. Borders of woods on Belle Isle. Rare.
160. var. blanda (Dew.) Boott. Roadsides on Belle Isle. Frequent.
161. var. varians, Bailey. In grassy situations on Belle Isle. Common.
162. tetanica, Schk. var. Woodii (Dew.) Bailey. Near Linden Park. Rare.
163. var. Meadii, (Dew.) Bailey, Near Linden Park. Rare.
164. digitalis, Willd. Linden Park. Common.
165. aurea, Nutt. Linden Park. Common.
166. pedicellata (Dew.) Britt. In woods at Linden Park. Common.
167. Pennsylvanica, Lam. Near Palmer Park. Common.
168. pubescens, Muhl. In woods on Belle Isle. Frequent.
169. stipata, Muhl. Low grounds on Belle Isle. Not common.
170. alopecoidea, Tuckerm., var. sparsispicata, Dew. Linden Park. Rare.
171. vulpinoidea, Mx. In woods on Belle Isle. Common.
172. xanthocarpa, Bicknell. Near Linden Park. Rare.
173. rosea, Schk. Roadsides on Belle Isle. Frequent.
174. var. radiata, Dew. In woods on Belle Isle. Common.
175. sparganioides, Muhl. Roadsides on Belle Isle. Common.
176. cephalophora, Muhl. In woods on Belle Isle. Common.
177. Muhlenbergii, Schk. Frequent on sterile grounds near Palmer Park; also Linden Park.
178. interior, Bailey. Marshy grounds on Belle Isle. Rare.
179. Muskingumensis, Schw. In woods on Belle Isle. Common.
180. tribuloides, Wahl. Common on low grounds on Belle Isle.
181. var. moniliformis (Tuckerm.) Britt. With the species. Common.
182. scoparia, Schk. Borders of woods on Belle Isle. Frequent.
183. cristatella, Britt. In woods on Belle Isle. Common.
184. straminea, Willd. Common on Belle Isle and elsewhere.
185. var. mirabilis (Dew.) Tuckerm. With the species. Common.
186. var. ferruginea (A. Gr.) Bailey. Near the old race-course. Rare.
187. var. festucacea (Willd.) Tuckerm. With the species. Common.

Order 4. Arales.

FAMILY 9. ARACEÆ. Arum Family.

49. ARISÆMA, Mart.
188. triphyllum (Lin.) Torr. Indian Turnip. Belle Isle woods and elsewhere. Rare.

50. ACORUS, Lin.
189. Calamus, Lin. Sweet Flag. Marshy grounds on Belle Isle. Common.

Order 5. Xyridales.

FAMILY 10. PONTEDERIACEÆ. Pickerel-weed Family.

51. PONTEDERA, Lin.
190. cordata, Lin. Pickerel-weed. Marshy grounds on Belle Isle. Common.

Order 6. Liliales.

FAMILY 11. JUNCACEÆ. Rush Family.

52. JUNCUS, Lin. Rush.
191. effusus, Lin. Marshy grounds on Belle Isle. Frequent.
192. Balticus, Willd. Sandy shores of Belle Isle. Frequent.

193. bufonius, Lin. Roadsides, etc., on Belle Isle and elsewhere. Common.
194. tenuis, Willd. With the last. Common.
195. var. secundus (Beauv.) Engelm. Near Palmer Park. Common.
196. pelocarpus, E. Meyer. Sandy shores of Belle Isle. Common.
197. Richardsonianus, Schult. With the last. Common.
198. nodosus, Lin. Low grassy shores of Belle Isle. Frequent.
199. Torreyi, Coville. With the last but more common.
200. Canadensis, J. Gay. Near Palmer Park. Common.
201. acuminatus, Mx. Near Linden Park. Frequent.

53. JUNCOIDES, Adans.
202. campestre (L.) O. K. Belle Isle woods and elsewhere. Common.

FAMILY 12. LILIACEÆ. Lily Family.

54. UVULARIA, Lin. Bellwort.
203. grandiflora, J. E. Smith. Linden Park. Rare.
204. sessiliflora, Lin. With the last but more frequent.

55. HEMEROCALLIS, Lin. Day Lily.
205. fulva, Lin. Vacant lots, etc., Detroit. Rare.

56. ALLIUM, Lin. Garlic.
206. Canadense, Lin. Roadsides on Belle Isle. Common.

57. LILIUM, Lin. Lily.
207. Canadense, Lin. Belle Isle woods. Common.
208. superbum, Lin. With the last but rare.

58. TULIPA, Lin. Tulip.
209. Gesneriana, Lin. This and the Hyacinth apparently persist without cultivation at the upper end of the Island and in other parts of Detroit, i. e., on ballast grounds and vacant lots.

59. ERYTHRONIUM, Lin. Adders Tongue.
210. Americanum, Ker. Belle Isle woods, etc. Common.
211. albidum, Nutt. With the last but not common.

60. HYACINTHUS, Lin. Hyacinth.
212. orientalis, Lin.

61. ALETRIS, Lin. Star Grass.
213. farinosa, Lin. Near Linden Park. Common.

62. ASPARAGUS, Lin.
214. officinalis, Lin. Vacant fields in Detroit. Common.

63. VAGNERA, Adans.
215. racemosa (Lin.) Morong. Wild Spikenard. Belle Isle woods. Common.

64. UNIFOLIUM, Adans. False Lily-of-the-valley.
216. Canadense (Desf.) Greene. Near Palmer Park. Common.

65. POLYGONATUM, Hill. Solomon's Seal.
217. biflorum (Walt.) Ell. Near Palmer Park. Common.
218. commutatum (R. & S.) Dietr. Belle Isle woods. Common.

66. TRILLIUM, Lin. Wake-robin.
219. grandiflorum (Mx.) Salisb., var. obovatum (Ph.) *T. obovatum* Ph. Fl. Sept. Am. 1, 245:1814. The petals are rose color or pink. In the species they are white and much larger. Belle Isle woods. Common.
220. erectum, Lin. Near Palmer Park. Rare.
221. cernuum, Lin. Belle Isle woods. Common.
222. undulatum, Willd. Near Linden Park. Rare.

67. SMILAX, Lin. Sarsaparilla.
223. herbacea, Lin. Carion-flower. Belle Isle woods. Rare.
224. var. humilis (Mill.) *S. humilis* Mill. Dict. Ed. 8, No. 11: 1768. *S. pulverulenta* Mx. Fl. Bor. Am. 2, 238: 1803. Belle Isle woods. Rare.
225. var. ecirrhata, Engelm. Belle Isle woods. Common.
226. hispida, Muhl. Belle Isle woods. Common.

FAMILY 13. AMARYLLIDACEÆ. Amaryllis Family.

68. NARCISSUS, Lin.
227. Poeticus, Lin.
228. biflorus, Curt.
These two species seem to persist along side of the avenues on Belle Isle and without cultivation in the woods at the upper end of Belle Isle.

69. HYPOXIS, Lin. Stargrass.
229. hirsuta (Lin.) Coville. On sparsely wooded dry soil on Belle Isle. Rare.

FAMILY 14. DIOSCOREACEÆ. Yam Family.

70. DIOSCOREA.
230. villosa, Lin. Wild Yam. Belle Isle woods. Common.

FAMILY 15. IRIDACEÆ. Iris Family.

71. IRIS, Lin.
231. versicolor, Lin. Marshy grounds Belle Isle. Frequent.

72. GEMMINGIA, Fabr.
232. Chinensis (Lin.) O. K. Waste grounds at Detroit. Rare.

73. SISYRINCHIUM, Lin. Blue-eyed Grass.
233. graminoides, Bicknell. In grassy places on Belle Isle and elsewhere. Frequent.
234. hastile, Bicknell. Marshy grounds on Belle Isle. Rare. A new species.
235. albidum, Raf. Common on Belle Isle and elsewhere.
236. Farwellii, Bicknell. A new species from near Birmingham.

ORDER 7. ORCHIDALES.

FAMILY 16. ORCHIDACEÆ. Orchid Family.

74. PERULARIA, Lindl.
237. flava (Lin.) *Orchis flava* Lin. Sp. Pl. 942: 1753. *Habenaria virescens* Spreng. Syst. 3.688: 1826. At Linden Park. Rare.

75. BLEPHARIGLOTIS, Raf.
238. lacera (Mx.) *Orchis lacera* Mx. Fl. Bor. Am., 2, 156: 1803. With the last. Frequent.
239. leucophæa (Nutt.) *Orchis leucophæa* Nutt. Trans. Am. Phil. Soc., (II) 5, 161:1833-37. Grassy places on southern side of Belle Isle. Frequent.

76. GYROSTACHYS, Pers.
240. cernua (L.) Kuntze. Ladies' Tresses. At Linden Park. Frequent.

77. LEPTORCHIS, Thouars.
241. Lœselii (L.) McM. Moist banks at Detroit. Rare.

SUBCLASS 2. DICOTYLEDONES.

SERIES 1. CHORIPETALÆ.

ORDER 8. SALICALES.

FAMILY 17. SALICACEÆ. Willow Family.

78. POPULUS, Lin. Poplar.
    242. tremuloides, Mx. American Aspen. Linden Park. Frequent.
    243. deltoides, Marsh. Cotton wood. Frequent on Belle Isle.

79. SALIX. Willow.
    244. amygdaloides, Anders. Belle Isle shores. Common.
    245. lucida, Muhl. On Belle Isle and elsewhere. Rare.
    246. fragilis, Lin. Northeast shores of Belle Isle. Rare.
    247. alba, Lin. var. vitellina (Lin.) Koch. On Belle Isle. Frequent.
    248. Babylonica, Lin. Common on Belle Isle and elsewhere.
    249. purpurea, Lin. South shores of Belle Isle. Rare.
    250. fluviatilis, Nutt. North shores of Belle Isle. Rare.
    251. Bebbiana, Sarg. At Linden Park. Frequent.
    252. tristis, Ait. At Linden Park. Frequent.
    253. discolor, Muhl. Shores of Belle Isle. Frequent.
    254. var. eriocephala (Mx.) Anders. At Linden Park. Rare.
    255. sericea, Marsh. At Linden Park. Frequent.
    256. petiolaris, J. E. Sm. On Belle Isle. Rare.
    257. candida, Fluegge. At old race-course. Frequent.
    258. cordata, Muhl. At Linden Park. Rare.
    259. var. angustata (Ph.) Anders. On Belle Isle. Frequent.

ORDER 9. JUGLANDALES.

FAMILY 18. JUGLANDACEÆ. Walnut Family.

80. HICORIA, Raf. Hickory.
    260. minima (Marsh.) Britt. Bitter-nut.
    261. ovata (Mill.) Britton. Shell-bark.
    262. var. borealis (Ashe.)
    H. borealis Ashe. Notes on Hickories, 1896.
    263. laciniosa (Mx.) Sarg. Shag-bark.
    264. alba (Lin.) Britt. Mocker-nut.
    265. glabra (Mill.) Britt. Pig-nut.
    266. var. odorata (Marsh.) Sarg.

All these hickories are more or less common on Belle Isle. The seeds of all except H. minima and of H. glabra are edible. The fruit of H. borealis has a thick husk completely separating into four valves, a thin shell, and a sweet seed; the bark is shaggy; it therefore is a variety of H. ovata. It differs from the species in having a smaller fruit (not over one-half so large) and smaller, narrower leaflets, foliage resiniferous shining and drying black when young.

ORDER 10. FAGALES.

FAMILY 19. BETULACEÆ. Birch Family.

81. BETULA, Lin.
    267. papyrifera, Marsh. Canoe Birch. Near Palmer Park. Common.

FAMILY 20. CORYLACEÆ. Hazel-nut Family.

82. CARPINUS, Lin.
268. Virginiana (Marsh.) Sudw. Hornbeam, Blue or water beach. Common on Belle Isle and elsewhere.

83. OSTRYA, Scop.
269. Virginiana (Mill.) Koch. At places in Detroit. Rare.

84. CORYLUS, Lin.
270. Americana, Walt. Hazel-nut. Common on Belle Isle and elsewhere.

FAMILY 21. CASTANEACEÆ. Oak Family.

85. FAGUS, Lin. Beech.
271. Americana-latifolia, Muench. Near Palmer Park. Rare.

86. QUERCUS, Lin. Oak.
272. rubra, Lin. On Belle Isle and near Palmer Park. Rare.
273. palustris, DuRoi. On Belle Isle. Common.
274. coccinea x palustris, Hill. Near Palmer Park. Common.
275. alba, Lin. On Belle Isle. Common.
276. macrocarpa, Mx. On Belle Isle. Frequent.
277. platanoides (Lam.) Sudw. Belle Isle, etc. Common.

ORDER 11. URTICALES.

FAMILY 22. ULMACEÆ. Elm Family.

87. ULMUS, Lin.
278. Americana, Lin. Elm. In woods on Belle Isle. Frequent.

FAMILY 23. LUPULACEÆ. Hop Family.

88. CANNABIS, Lin.
279. sativa, Lin. Hemp. On ballast grounds, etc., Detroit. Rare.

FAMILY 24. URTICACEÆ. Nettle Family.

89. URTICA, Lin.
280. dioica, Lin. Stinging Nettle. North shores Belle Isle. Frequent.
280a. gracilis, Ait. Near water works. Rare.

90. URTICASTRUM, Fabr.
281. divaricatum (Lin.) O. K. Wood Nettle. Belle Isle woods. Common.

91. ADICEA, Raf.
282. pumila (Lin.) Raf. Clearweed. Belle Isle woods. Common.

ORDER 12. SANTALALES.

FAMILY 25. SANTALACEÆ. Sandalwood Family.

92. COMANDRA, Nutt.
283. umbellata (Lin.) Nutt. Bastard Toad Flax. At Linden Park. Frequent.

ORDER 13. ARISTOLOCHIALES.

FAMILY 26. ARISTOLOCHIACEÆ. Birthwort Family.

93. ASARUM, Lin.
284. Canadense, Lin. Wild Ginger. Belle Isle woods. Frequent.

Order 14. Polygonales.

FAMILY 27. POLYGONACEÆ. Buckwheat Family.

94. RUMEX, Lin. Dock.
285. Acetosella, Lin. Sour Sab, Sorrel. Roadsides on Belle Isle. Common.
286. crispus, Lin. Yellow Dock. On Belle Isle, etc. Common.
287. obtusifolius, Lin. Bitter Dock. With the last. Common.

95. FAGOPYRUM, Gærtn.
288. Fagopyrum (Lin.) Karst. Buckwheat. Belle Isle, waste places, etc. Rare.

96. POLYGONUM, Lin.
289. amphibium, Lin. Persicaria. Belle Isle canals. Common.
290. Hartwrightii, A. Gr. On dry grounds on Belle Isle. Common.
291. emersum (Mx.) Britton. With the last. Common.
292. incarnatum, Ell. Low grounds on Belle Isle. Common.
293. lapathifolium. Lin. Borders of canals on Belle Isle. Rare.
294. var. incanum (Schmidt) Koch. Near water on Belle Isle. Rare.
295. nodosum, Pers. Waste places at Detroit. Common.
296. Pennsylvanicum, Lin. Low grounds on Belle Isle. Common.
297. Persicaria, Lin. Roadsides, etc., on Belle Isle. Common.
298. hydropiperoides, Mx. Waterpepper. Grassy shores on Belle Isle. Rare.
299. var. Macounii, Small. Borders of pools at Linden Park. Rare.
300. Hydropiper, Lin. Smart-weed. Waste places Belle Isle, etc. Common.
301. punctatum, Ell. Shores of Belle Isle. Common.
302. orientale, Lin. Prince's Feather. Waste places at Detroit. Rare.
303. Virginianum, Lin. Knotweed. Belle Isle woods. Common.
304. aviculare, Lin. Knotweed. Roadsides on Belle Isle, etc. Common.
305. littorale, Link. With the last. Common.
306. Rayi, Babington. Roadsides on Belle Isle, etc. Rare.
307. erectum, Lin. Roadsides on Belle Isle, etc. Common.
308. Convolvulus, Lin. Bindweed. Waste places on Belle Isle, etc. Common.
309. scandens, Lin. Belle Isle and Palmer Park. Rare.
310. sagittatum, Lin. Near Palmer Park. Common.

Order 15. Chenopodiales.

FAMILY 28. CHENOPODIACEÆ. Goosefoot Family.

97. CHENOPODIUM, Lin.
311. album, Lin. Pigweed. On Belle Isle. Rare.
312. viride, Lin. On Belle Isle and elsewhere. Common. Also a low prostrate, spreading form, forming a patch often three feet in diameter. Leaves under a half inch in length, not larger than those of Chenopodium vulvaria; linear.
313. leptophyllum (Moq.) Nutt. (?) A plant with a general habit and aspect of this species but the leaves are destitute of mealiness underneath. Perhaps a form of *C. viride*. Waste places at Detroit. Rare.
314. glaucum, Lin. Goosefoot. On Belle Isle, etc. Common.
315. murale, Lin. Roadsides, etc., at Detroit. Frequent.
316. hybridum, Lin. Waste places on Belle Isle. etc. Common.
317. Botrys. Lin. Jerusalem Oak. Waste grounds at Detroit. Common.
318. anthelminticum, Lin. Wormseed. Waste grounds at Detroit. Common.
319. vulvaria, Lin. Waste grounds at Detroit. Rare.

98. BETA, Lin.
320. vulgaris, Lin. Beet. Waste grounds at Detroit. Rare.

99. ATRIPLEX, Lin. Orachi.
321. hortensis, Lin. Garden Orache. With the last. Rare.
322. patula, Lin. Waste grounds at Detroit. Common.
323. hastata, Lin. With the last. Frequent.

100. SALSOLA, Lin.
324. Tragus, Lin. Russian Thistle. Waste grounds at Detroit. Rare.

FAMILY 29. AMARANTHACEÆ. Amaranth Family.

101. AMARANTHUS, Lin.
325. retroflexus, Lin. Pigweed. Roadsides on Belle Isle. Common.
326. hypochondriacus, Lin. Ballast grounds at Detroit. Frequent.
327. chlorostachys, Willd. On Belle Isle, etc. Frequent.
328. paniculatus, Lin. Sandy shores of Belle Isle. Rare.
329. blitoides, Wats. Waste places at Detroit. Common.
330. Græcizans, Lin. Roadsides, etc., on Belle Isle and elsewhere. Common.
331. deflexus, Lin. Ballast grounds at Detroit. Rare.

102. ACNIDA, Lin.
332. tamariscina (Nutt.) Wood., var. prostata, Uline & Bray. Sandy shores of Belle Isle. Rare.

FAMILY 30. PHYTOLACCACEÆ. Pokeweed Family.

103. PHYTOLACCA, Lin.
333. Americana, Lin. *P. decandra* L. Sandy shores of Belle Isle. Rare.

FAMILY 31. AIZOACEÆ. Carpetweed Family.

104. MOLLUGO, Lin.
334. verticillata, Lin. Waste grounds at Detroit. Frequent.

FAMILY 32. PORTULACACEÆ. Purslane Family.

105. CLAYTONIA, Lin.
335. Virginica, Lin. Spring Beauty. Belle Isle woods, etc. Common.

106. PORTULACA, Lin.
336. oleracea, Lin. Pussley. Roadsides on Belle Isle. Frequent.
337. grandiflora, Hook. Sun-plant. Waste grounds, etc., at Detroit. Rare.

FAMILY 33. CARYOPHYLLACEÆ. Pink Family.

107. AGROSTEMMA, Lin.
338. Githago, Lin. Corn Cockle. Roadsides, etc., on Belle Isle. Common.

108. SILENE, Lin.
339. antirrhina, Lin. Catchfly. Roadsides on Belle Isle. Common.
340. noctiflora, Lin. With the last. Frequent.

109. LYCHNIS, Lin.
341. alba, Mill. Campion. East shore of Belle Isle. Common.

110. SAPONARIA, Lin.
342. officinalis, Lin. Bouncing Bet. Soapwort. Waste places at Detroit. Rare.

111. VACCARIA, Lin.
343. Vaccaria (Lin.) Britt. Corn-herb. On ballast grounds at Detroit. Frequent.

112. DIANTHUS, Lin.
344. barbatus, Lin. Sweet William. Northern grassy shores of Belle Isle. Frequent.
345. Armeria, Lin. Deptford Pink. Near the water works. Frequent.

113. STELLARIA, Lin.
346. media (Lin.) Cyr. Chickweed. Roadsides on Belle Isle, etc. Common.
347. longifolia, Muhl. Stitchwort. Low grassy places, Belle Isle, etc. Frequent.

114. CERASTIUM, Lin.
348. viscosum, Lin. Mouse-eared Chickweed. Belle Isle. Rare.
349. vulgatum, Lin. With the last, but common.
350. oblongifolium, Torr. Sandy shores on Belle Isle. Common.

115. ARENARIA, Lin.
351. serpyllifolium, Lin. Sandwort. Roadsides on Belle Isle. Common.

116. MŒHRINGIA, Lin.
352. lateriflora (Lin.) Fenzl. Sandwort. Shores of Belle Isle. Rare.

ORDER 16. RANALES.

FAMILY 34. NYMPHÆACEÆ. Waterlily Family.

117. NYMPHÆA, Lin.
353. advena, Ait. Yellow Pond Lily. Common in canals on Belle Isle.

118. NELUMBO, Adans.
354. lutea (Willd.) Pers. American Lotus. In River Rouge at Detroit. Rare.

FAMILY 35. RANUNCULACEÆ. Crowfoot Family.

119. HELLEBORUS, Lin.
355. viridis, Lin. Hellebore. Sandy shores on Belle Isle. Rare.

120. ISOPYRUM, Lin.
356. biternatum (Raf.) T. & G. False Rue, Anemone. Belle Isle woods. Rare.

121. NIGELLA, Lin.
357. Damascena, Lin. Fennel Flower. In waste places, etc., at Detroit. Rare.

122. ACTÆA, Lin.
358. rubra (Ait.) Willd. Baneberry. Belle Isle woods. Frequent.
359. alba (Lin.) Mill. With the last, but rare.

123. AQUILEGIA, Lin.
360. Canadensis, Lin. Wild Columbine. Near Palmer Park. Common.

124. DELPHINIUM, Lin.
361. Consolida, Lin. Larkspur.
362. Ajacis, Lin.
These two species of Larkspur have escaped from cultivation and are occasionally found on waste grounds, etc.

125. ANEMONE, Lin. Wind-flower.
363. cylindrica, A. Gr. Near Linden Park. Common.
364. Virginiana, Lin. Belle Isle woods. Frequent.
365. Canadensis, Lin. With the last, but more common.
366. quinquefolia, Lin. In open woods on Belle Isle, etc. Frequent.

126. HEPATICA, Scop.
367. acuta (Ph.) Britt. Liverwort. In open woods on Belle Isle. Rare.

127. SYNDESMON, Hoffmseg.
368. thalictroides (Lin.) Hoffmseg. Rue-Anemone. With the last. Rare.

128. RANUNCULUS, Lin.
369. divaricatus, Schrank. Water Crowfoot. Detroit River. Frequent.
370. delphinifolius, Torr., var. terrestris (A. Gr.)
R. multifidus var. terrestris A. Gr. Man. Ed. 5, 41: 1867. Marshy grounds on Belle Isle. Rare.
371. reptans, Lin., var. intermedius (Hk.) T. & G. Spearwort. Grassy shores on Belle Isle. Common.
372. abortivus, Lin. Crowfoot. At Linden Park. Common.
373. sceleratus, Lin. In moist ditches on Belle Isle. Common.
374. recurvatus, Poir. In moist woods on Belle Isle. Frequent.
375. acris, Lin. Linden Park. Rare.
376. Pennsylvanicus, Lin. f. Shores of Belle Isle. Rare.
377. septentrionalis, Poir. Belle Isle woods. Common.

129. THALICTRUM, Lin.
378. dioicum, Lin. Meadow-Rue. Borders of woods on Belle Isle. Common.
379. purpurascens, Lin. With the last. Common.

FAMILY 36. BERBERIDACEÆ. Barberry Family.

130. BERBERIS, Lin.
380. vulgaris, Lin. Barberry. Vacant lots, etc. Rare.

131. JEFFERSONIA, Bart.
381. diphylla (Lin.) Pers. Twin-Leaf. Belle Isle woods. Rare.

132. PODOPHYLLUM, Lin.
382. peltatum, Lin. Mandrake. Belle Isle woods. Common.

FAMILY 37. MENISPERMACEÆ. Moonseed Family.

133. MENISPERMUM, Lin.
383. Canadense, Lin. Moonseed. Climbing over shrubbery on Belle Isle. Frequent.

FAMILY 38. MAGNOLIACEÆ. Magnolia Family.

134. LIRIODENDRON, Lin. Tulip Tree.
384. Tulipifera, Lin. Whitewood, Yellow Poplar. Palmer Park and Linden Park. Rare.

FAMILY 39. LAURACEÆ. Laurel Family.

135. SASSAFRAS, Ness. & Eberm.
385. Sassafras (Lin.) Karst. At Linden Park. Frequent.

136. BENZOIN, Fabric.
386. Benzoin (Lin.) Coulter. Belle Isle woods. Rare.

ORDER 17. PAPAVERALES.

FAMILY 40. FUMARIACEÆ. Fumitory Family.

137. CUCULLARIA, Juss. Ex. Lin. Sp. Pl. 699: 1753.
387. Cucullaria (Lin.) *Fumaria Cucullaria* Lin. Sp. Pl. 699: 1753. Dutchman's Breeches. Linnæus, l. c., quotes "Cucullaria, Juss." as a synonym of this plant. It thus antedates Bikukulla, Adans by ten years. Moist open woods on Belle Isle. Common.

FAMILY 41. CRUCIFERÆ. Mustard Family.

138. LEPIDIUM, Lin.
388. campestre, Lin. Cress. On waste places on Belle Isle, etc. Rare.
389. Virginicum, Linn. Peppergrass. Roadsides on Belle Isle, etc. Frequent.
390. apetalum, Willd. With the last, but more common.

139. COCHLEARIA, Lin.
391. Armoracia, Lin. Horseradish. Waste places at Detroit. Frequent.

140. SISYMBRIUM, Lin.
392. officinale (Lin.) Scop. Hedge Mustard. Waste places on Belle Isle, etc. Common.

141. SINAPIS, Lin.
393. alba, Lin. White Mustard. Ballast grounds on Belle Isle and mainland. Common.

142. BRASSICA, Lin. Turnip, Rutabaga, etc.
394. nigra (Lin.) Koch. Black Mustard. Belle Isle. Rare.
395. juncea (Lin.) Cosson. India Mustard. On Belle Isle. Common.
396. arvensis (Lin.) B. S. P. Charlock. Belle Isle. Common.
397. campestris Lin. Turnip. On ballast grounds at Detroit. Frequent.

143. DIPLOTAXYS, DC.
398. muralis (Lin.) DC. On ballast grounds at Detroit. Common.

144. RAPHANUS, Lin. Radish.
399. Raphanistrum, Lin. White Charlock. On ballast ground at Detroit. Rare.

145. BARBAREA, Ait. f.
400. stricta, Andrz. Winter Cress. Near Palmer Park. Rare.

146. RORIPA, Scop.
401. sylvestris (Lin.) Bess. Water Cress. Ditches and roadsides at Detroit. Common.
402. palustris (Lin.) Bess. Moist grounds on Belle Isle. Common.
403. hispida (Desv.) Britt. With the last. Common.

147. CARDAMINE, Lin.
404. hirsuta, Lin. Bitter Cress. Moist places on Belle Isle. Rare.
405. Pennsylvanica, Muhl. Moist places on Belle Isle and elsewhere. Common.
406. purpurea (Torr.) Britt. Moist woods on Belle Isle. Common.
407. bulbosa (Screb.) B. S. P. At Linden Park. Frequent.

148. DENTARIA, Lin. Pepper-root.
408. laciniata, Muhl. Toothwort. Moist woods on Belle Isle. Common.

149. Bursa, Weber. Shepherd's Purse.
409. Bursa-Pastoris (Lin.) Britt. Roadsides, etc., on Belle Isle, etc. Common.

150. CAMELINA, Crantz.
410. sativa (Lin.) Crantz. False Flax. Waste places on Belle Isle. etc. Frequent.

151. SOPHIA, Adans. Tansy Mustard.
411. pinnata (Walt.) Britt., var. brachycarpa (Richards.) *Sisymbrium brachycarpon* Richards. Frank. Journ. 744:1823. Leaves stems, and inflorescence sparsely glandular, otherwise glabrous; pods uni- or bi-seriate even on the same plant. Intermediate between S. pinnata and S. incisa. Roadsides on Belle Isle. Common.

152. ARABIS, Lin.
412. Canadensis, Lin. Sickle-pod. Near Palmer Park. Frequent.
413. glabra (Lin.) Bernh. Tower Mustard. Unimproved property at Detroit. Frequent.

153. ERYSIMUM, Lin.
414. cheiranthoides, Lin. Treackle Mustard. Roadsides on Belle Isle. Frequent.

154. ALYSSUM, Lin.
415. alyssoides (Lin.) Gouan. Sweet alyssum. On the southeast shore of Belle Isle where it is quite frequent.

155. KONIGA, Adans.
416. maritima (Lin.) R. Br. Waste place at Detroit. Frequent.
156. HESPERIS, Lin.
417. matronalis, Lin. Dame's Rocket. With the last. Frequent.

FAMILY 42. CAPPARIDACEÆ. Caper Family.

157. CLEOME, Lin.
418. spinosa, Lin. Spider-flower. Waste grounds at Detroit. Rare.

158. POLANISIA, Raf.
419. graveolens, Raf. Sandy places on Belle Isle. Frequent.

FAMILY 43. RESEDACEÆ. Mignonette Family.
159. RESEDA, Lin.
420. alba, Lin. On ballast grounds at Detroit. Rare.

ORDER 18. ROSALES.

FAMILY 44. CRASSULACEÆ. Orpine Family.

160. PENTHORUM, Lin.
421. sedoides, Lin. Ditch Stone-crop. Ditches, etc., Belle Isle. Common.

FAMILY 45. SAXIFRAGACEÆ. Saxifrage Family.

161. HEUCHERA, Lin.
422. Americana, Lin. Alum-root. Dry woods on Belle Isle. Rare.

162. MITELLA, Lin. Mitrewort.
423. diphylla, Lin. Bishop's Cap. Near Palmer Park. Frequent.

163. RIBES, Lin. Gooseberry, Currant.
424. Cynosbati, Lin. Wild Gooseberry, Dogberry.
425. floridum, L'Her. Wild Black Currant. Both species are common in woods on Belle Isle.

FAMILY 46. HAMAMELIDACEÆ. Witch Hazel Family.

164. HAMAMELIS, Lin.
426. Virginiana, Lin. Witch Hazel. Frequent in sparsely wooded places at Detroit.

FAMILY 47. ROSACEÆ. Rose Family.

165. SPIRÆA, Lin. Meadow Sweet.
427. salicifolia, Lin. Quaker Lady. Moist grounds on Belle Isle.
428. tomentosa, Lin. Hardhack. Near Linden Park. Rare.

166. PORTERANTHUS, Britt.
429. stipulatus (Muhl.) Britt. American Ipecac. Belle Isle. Rare.

167. RUBUS, Lin. Blackberry, Raspberry.
430. odoratus, Lin. Near Linden Park. Rare.
431. strigosus, Mx. Red Raspberry. Roadsides on Belle Isle. Frequent.
432. neglectus, Peck. Dry woods on Belle Isle. Rare.
433. occidentalis, Lin. Black Raspberry. With the last two species. Common.
434. Americanus (Pers.) O. A. F. Dwarf Raspberry. Low grounds at upper end of Belle Isle. Common.
435. villosus, Ait. Blackberry. Dry grounds at Linden Park. Frequent.
436. hispidus, Lin. Low grounds at Linden Park. Frequent.
437. Baileyanus, Britt. Dry woods at upper end of Belle Isle. Common.
438. Canadensis, Lin. Dewberry. At Linden Park. Frequent.

168. FRAGARIA, Lin. Strawberry.
439. Virginiana, Duchesne. In dry grounds on Belle Isle. Common.

169. POTENTILLA, Lin.
440. argentea, Lin. Hoary Cinquefoil. Dry grounds at Linden Park. Rare.
441. Monspeliensis, Lin. Dry soils and waste places at Linden Park. Common.
442. var. Norvegica (Lin.) O. A. F. Moist places on Belle Isle. Common. The type is the low, simple form of wet, grassy, meadows; the lower leaflets being broadly ovate or nearly round. The var. is the larger, coarser branched plant of drier situations; the leaflets are oblong-obovate or oblong-lanceolate.
443. Anserina, Lin. Silver-weed. Low moist shores of Belle Isle. Common.
444. Canadensis, Lin. Five-finger. Dry soils on Belle Isle. Frequent.
445. var. pumila (Poir.) Lehm. Sunburnt fields at Linden Park. Frequent.
446. var. simplex (Mx.) T. & G. Moist grounds on Belle Isle. Frequent.

170. GEUM, Lin.
447. vernum (Raf.) T. & G. Spring Avens. Belle Isle woods. Common.
448. Canadense, Jacq. White Avens. Belle Isle woods. Common.
449. Virginianum, Lin. Rough Avens. Frequent on upper end of Belle Isle.
450. strictum, Ait. Yellow Avens. Moist grounds at Linden Park. Frequent.

171. AGRIMONIA, Lin. Agrimony.
451. hirsuta (Muhl.) Bicknell.
452. mollis (T. & G.) Britton.
453. parviflora, Ait. All common in moist or dry woods on Belle Isle.

172. Rosa, Lin.
454. setigera, Mx. Prairie Rose.
455. blanda, Ait. Meadow Rose.
456. Carolina, Lin. Swamp Rose.
457. humilis, Marsh. Pasture Rose. All more or less frequent on banks, etc., on Belle Isle; the prairie rose is very common in moist woods.

173. MALUS, Mill. Apple.
458. coronaria (Lin.) Mill. Crab Appple. Belle Isle woods, etc. Common.

174. ARONIA, Medic. Choke Cherry.
459. arbutifolia (Lin.) Medic. Belle Isle thickets. Rare.
460. nigra (Willd.) Britton. At Linden Park. Rare.

175. AMELANCHIER, Medic.
461. Canadensis (Lin.) Medic.
462. Botryapium (Lin. f.) DC. Known as Shad-bush, Sugar-plum, Sugar-pear, May-cherry, June-berry, service-berry. Both species are found on Belle Isle and elsewhere.

176. CRATÆGUS, Lin. Haw; Thorn Apple.
 463. Crus-Galli, Lin. Belle Isle thickets, etc. Common.
 464. punctata, Jacq. With the preceding. Frequent.
 465. coccinea, Lin. Thickets on Belle Isle. Frequent.
 466. macracantha, Lodd. With the last. Rare.
 467. mollis (T. & G.) Scheele. Thickets on Belle Isle, etc. Common.
 468. tomentosa, Lin. With the last. Common.

177. PRUNUS, Lin. Plums and Cherries.
 469. Americana, Marsh. Plum. Belle Isle woods. Frequent.
 470. Pennsylvanica, Lin. f. Cherry. Near Palmer Park. Frequent.
 471. Virginiana, Lin. Choke Cherry. Belle Isle thickets. Rare.
 472. serotina, Ehrh. Black Cherry. Near Linden Park. Rare.

FAMILY 48. LEGUMINOSÆ. Pea Family.

178. BAPTISIA, Vent.
 473. tinctoria (Lin.) R. Br. Wild Indigo.
 474. leucantha, T. & G. These species of Wild Indigo are found near Linden Park; the first is rather common; the latter rare.

179. CROTALARIA, Lin.
 475. sagittalis, Lin. Rattle-box. Near Linden Park. Rare.

180. LUPINUS, Lin.
 476. perennis, Lin. Wild Lupine, Frequent near Palmer Park.
 477. polycarpus, Greene. A Pacific Coast species. A waif of ballast grounds at Detroit.

181. MEDICAGO, Lin.
 478. sativa, Lin. Alfalfa, Lucerne. Ballast grounds. Rare.
 479. lupulina, Lin. Black Medic. Nonesuch. Waste places on Belle Isle, etc. Common.
 480. denticulata, Willd. Ballast grounds. Rare.

182. MELILOTUS, Lam. Sweet Clover.
 481. alba, Desv. White Melilot. Waste grounds. Common.
 482. Melilotus-officinalis (Lin.) *Trifolium Melilotis-officinalis* Lin. Sp. Pl. 765:1753. Yellow Melilot. With the last; also on Belle Isle. Common.

183. TRIFOLIUM, Lin. Clover.
 483. agrarium, Lin. Hop Clover. Near Linden Park. Rare.
 484. pratense, Lin. Red Clover. Grassy places on Belle Isle, etc. Common.
 485. hybridum, Lin. Alsike Clover. Roadsides on Belle Isle. Common.
 486. repens, Lin. White Clover. Grassy places on Belle Isle, etc. Common.
 487. furcatum, Lindl.
 488. depauperatum, Desv. The last two species are waifs from the Pacific Coast.

184. AMORPHA, Lin.
 489. canescens, Pursh. Shoe Strings, Lead Plant. Near old race-course. Rare.

185. ROBINIA, Lin.
 490. viscosa, Vent. Locust. Detroit. Rare.

186. ASTRAGALUS, Lin.
 491. Carolinianus, Lin. Milk Vetch. Shores of Belle Isle. Rare.

187. MEIBOMIA, Fabric. Tick-trefoil.
 492. grandiflora (Walt.) O. K.
 493. paniculata (Lin.) O. K.
 494. Dillenii (Darl.) O. K.
 495. Canadense (Lin.) O. K. All these species of Tick-trefoil, except the last, which is scarce, are common in the woods on Belle Isle.

188. LESPEDEZA, Mx. Bush-Clover.
    496. frutescens (Lin.) Britton.
    497. hirta (Lin.) Ell.
    498. capitata, Mx. Near Linden Park the Bush Clovers are common, except the first, which is scarce.

189. VICIA, Lin. Vetch or Tare.
    499. Cracca, Lin. Linden Park. Rare.
    500. sativa, Lin. Roadsides on Belle Isle. Rare.

190. LATHYRUS, Lin. Pea.
    501. palustris, Lin. Dry woods on Belle Isle. Common.
    502. myrtifolius, Muhl. With the preceding, but scarce.

191. FALCATA, Gmel.
    503. comosa (Lin.) O. K. Moist thickets on Belle Isle. Common.

192. PHASEOLUS, Lin. Bean.
    504. polystachyus (Lin.) B. S. P. Thickets on Belle Isle. Rare.
    505. vulgaris, Lin., var. nana (Lin.) Steud. On ballast grounds and waste places. Rare.

193. STROPHOSTYLES, Ell.
    506. helvola (Lin.) Britt. In sandy places on Belle Isle and elsewhere. Frequent.

194. GYMNOCLADUS, Lam. Kentucky Coffee-tree.
    507. dioica (Lin.) Koch. Belle Isle thickets. Rare.

195. GLEDITSIA, Lin.
    508. triacanthos, Lin. Honey Locust. Belle Isle woods. Frequent.

ORDER 19. GERANIALES.

FAMILY 49. GERANIACEÆ.

196. GERANIUM, Lin.
    509. maculatum, Lin. Common in moist woods on Belle Isle.
    510. Carolinianum, Lin. Frequent in shady places on Belle Isle, etc.
    511. Bicknellii, Britton. With the preceding, but more common.

FAMILY 50. OXALIDACEÆ. Wood Sorrel Family.

197. OXALIS, Lin.
    512. stricta, Lin. *O. cymosa* Small. Wood-sorrel. Borders of woods on Belle Isle. Common.

FAMILY 51. LINACEÆ. Flax Family.

198. LINUM, Lin.
    513. usitatissimum, Lin. Flax. Sandy places on Belle Isle and elsewhere. Frequent.
    514. humile, Mill. Roadsides on Belle Isle. Rare.

FAMILY 52. RUTACEÆ. Rue Family.

199. ZANTHOXYLUM, Lin.
    515. Americanum, Mill. Prickley Ash. Thickets on Belle Isle. Common.

FAMILY 53. SIMARUBACEÆ. Ailanthus Family.

200. AILANTHUS, Desf.
    516. glandulosa, Desf. Tree-of-Heaven. Detroit. Frequent.

FAMILY 54. POLYGALACEÆ. Milkwort Family.

201. POLYGALA, Lin. Milkwort.
517. verticillata, Lin. Grassy fields. Frequent.
518. viridescens, Lin. Near Linden Park. Scarce.
519. var. sanguinea (Lin.) *P. sanguinea* Lin. Sp. Pl. 705: 1753. The type has the flowers greenish or white; the variety has the flowers rose-purple and is the common form.

FAMILY 55. EUPHORBIACEÆ. Spurge Family.

202. ACALYPHA, Lin.
520. Virginica, Lin. In thickets on Belle Isle. Common.

203. RICINUS, Lin.
521. communis, Lin. Castor-plant. In waste places. Rare.

204. EUPHORBIA, Lin.
522. maculata, Lin. Sandy places. Common on Belle Isle and elsewhere.
523. hirsuta (Torry) Wiegand. Sandy or grassy places near Palmer Park, Belle Isle, etc. Rare.
524. nutans, Lag. Waste places. Frequent.
525. corollata, Lin. Flowering Spurge. Linden Park. Common.
526. marginata, Ph. Snow-on-the-Mountain. Waste places. Frequent.
527. obtusata, Ph. Borders of woods on Belle Isle. Rare.
528. platyphylla, Lin. Shores of Belle Isle. Rare.
529. Helioscopia, Lin. Roadsides on Belle Isle. Frequent.

ORDER 20. SAPINDALES.

FAMILY 56. ANACARDIACEÆ. Sumach Family.

205. RHUS, Lin. Sumach.
530. copallina, Lin. Dwarf or Mountain Sumach. Near Linden Park. Common.
531. hirta (Lin.) Sudw. Belle Isle. Frequent in thickets.
532. glabra, Lin. Scarlet Sumach. In dry woods on Belle Isle. Common.
533. radicans, Lin. Poison Oak. Climbing trees by radicles. Belle Isle. Common.
534. var. pubescens (Mill.)
Toxicodendron pubescens Mill. Dict. No. 2: 1868. *Rhus Toxicodendron var. quercifolium* Mx. Fl. Bor. Am. I. 183: 1803. This is a low shrub with extensively creeping under-ground stems which send up branches rarely over a foot in height; never climbing; leaflets oval, acute or acuminate and with a broadly or narrowly cuneate base; deeply 3 to 5 (generally 3) incisely-lobed, oftentimes with one margin entire; lobes ovate, acute or acuminate, margins entire.

FAMILY 57. AQUIFOLIACEÆ. Holly Family.

206. ILEX, Lin.
535. verticillata (Lin.) A. Gr. Black Alder. Moist woods on Belle Isle. Common.

FAMILY 58. CELASTRACEÆ. Staff-tree Family.

207. EUONYMUS, Lin.
536. obovatus, Nutt. Strawberry bush. Moist thickets on Belle Isle. Rare.
537. atropurpureus, Jacq. Wahoo. Belle Isle woods. Common.

208. CELASTRUS, Lin.
538. bullatus, Lin. *C. scandens* L. Climbing over shrubs on Belle Isle. Common.

FAMILY 59. ACERACEÆ. Maple Family.

209. ACER, Lin.
539. saccharinum, Lin. Silver maple. Low grounds. Rare.
540. rubrum, Lin. Red Maple. Moist woods on Belle Isle. Frequent.

FAMILY 60. BALSAMINACEÆ. Jewel-weed Family.

210. IMPATIENS, Lin.
541. 'biflora, Walt. Touch-me-not. Moist grounds on Belle Isle. Common.

ORDER 21. RHAMNALES.

FAMILY 61. RHAMNACEÆ. Buckthorn Family.

211. CEANOTHUS, Lin.
542. Americanus, Lin. New Jersey Tea. Linden Park. Common.

FAMILY 62. VITACEÆ. Grape Family.

212. VITIS, Lin.
543. vulpina, Lin. Riverside Grape. Common on Belle Isle.

213. PARTHENOCISSUS, Planch.
544. quinquefolia (Lin.) Planch., var. lacinata, Planch. *P. vitacea*, (Knerr.) A. S. Hitchcock. Internodes of the stem and branches 2′-4′ long; leaves glabrous, or sparcely short-pubescent; tendrils mostly without terminal adhering disks; aerial roots none. Moist grounds on Belle Isle. Frequent.
545. var. hirsuta (Donn.) T. & G. Ex. Planch. Aerial roots numerous; high-climbing; internodes of the stem and branches ¼ to ¾ inch long; leaves pubescent on both sides, and pilose on the mid-vein underneath; tendrils none. Moist woods on Belle Isle. Frequent.

ORDER 22. MALVALES.

FAMILY 63. TILIACEÆ. Linden Family.

214. TILIA, Lin.
546. Americana, Lin. Basswood. Moist woods Belle Isle. Frequent.

FAMILY 64. MALVACEÆ. Mallow Family.

215. ALTHÆA, Lin.
547. officinalis, Lin. Marshmallow. In waste places, etc. Frequent.

216. MALVA, Lin.
548. rotundifolia, Lin. Mallow. Roadsides, etc., on Belle Isle and elsewhere. Common.
549. crispa, Lin. Waste places, etc. Common.

217. ABUTILON, Gærtn.
550. Abutilon (Lin.) Rusby. Indian Mallow. Waste places, etc. Common.

218. HIBISCUS, Lin.
551. Trionum, Lin. Venice Mallow. With the last. Frequent.

ORDER 23. PARIETALES.

FAMILY 65. HYPERICACEÆ. St. Johns-Wort Family.

219. ASCYRON, Lin.
552. hypericoides, Lin. St. Andrew's Cross. Woods on Belle Isle. Rare.

220. HYPERICUM, Lin. St. John's-Wort.
553. prolificum, Lin. Sandy borders of woods on Belle Isle and elsewhere. Frequent.
554. perforatum, Lin. Waste places, Belle Isle, etc. Common.
555. maculatum, Walt., var. corymbosum (Muhl.)
H. corymbosum, Muhl. Ex. Willd. Sp. Pl. 3. 1457: 1803. Differing from the type in having less clasping leaves and styles only one-half as long (about equalling the length of the pod). Woods on Belle Isle. Common.
556. mutilum, Lin. Linden Park. Common.
557. majus (A. Gr.) Britt. Near Palmer Park. Rare.
558. Canadense, Lin. Low grassy places. Frequent.

FAMILY 66. CISTACEÆ. Rock Rose Family.

221. HELIANTHEMUM, Mx.
559. majus (Lin.) B. S. P. Frostweed. Near Palmer Park, etc. Common.
560. Canadense (Lin.) Mx. Linden Park. Rare.

222. LECHEA, Lin.
561. villosa, Ell. Pinweed. Linden Park. Common.

FAMILY 67. VIOLACEÆ. Violet Family.

223. VIOLA, Lin. Violet, Pansy.
562. obliqua, Hill. Low grounds on Belle Isle, etc. Common.
563. sororia, Willd. Rich woods on Belle Isle. Rare.
564. ovata, Nutt. Belle Isle and near Palmer Park. Frequent.
565. emarginata (Nutt.) Le Conte. Near Palmer Park and Linden Park. Rare.
566. blanda, Willd. Shores of Belle Isle. Frequent.
567. var. amœna (Le C.) B. S. P. Near Palmer Park. Frequent.
568. lanceolata, Lin. Woods on Belle Isle. Rare.
569. pubescens, Ait. Dry woods on Belle Isle, etc. Common.
570. var. eriocarpa (Schw.) Nutt. With the species. Common.
571. Canadensis, Lin. Woods on Belle Isle. Rare.
572. Labradorica, Schrank. Common in moist grounds on Belle Isle, etc.
573. rostrata, Ph. Rich woods near Palmer Park. Rare.
574. tricolor, Lin. Pansy. Waste places. Frequent.
575. tenella, Muhl. With V. tricolor, but rare.

ORDER 24. MYTRALES.

FAMILY 68. LYTHRACEÆ. Loosestrife Family.

224. LYTHRUM, Lin.
576. alatum, Lin. Loosestrife. Low grounds, Belle Isle and elsewhere. Common.

225. DECODON, J. F. Gmel.
577. verticillatus (Lin.) Ell. Swamp Loosestrife. Near water works. Frequent.

FAMILY 69. ONAGRACEÆ. Evening Primrose Family.

226. ISNARDIA, Lin.
578. palustris, Lin. Marsh Purslane. Common near Palmer Park.

227. LUDWIGIA, Lin.
579. polycarpa, Short and Peter. Frequent at Linden Park.

228. EPILOBIUM, Lin.
580. spicatum, Lam. Fireweed. Dry grounds on Belle Isle. Frequent.
581. coloratum, Muhl. Willow Herb. Low grounds on Belle Isle. Common.
582. adenocaulon, Hausk. With the preceding. Common.

229. ŒNOTHERA, Lin.
583. biennis, Lin. Evening Primrose. Shores of Belle Isle. Common.
584. laciniata, Hill. Waste places. Rare.

230. GAURA, Lin.
585. biennis, Lin. Near Linden Park. Common.

231. CIRCÆA, Lin.
586. Lutetiana, Lin. Enchanter's Nightshade. Belle Isle woods. Common.

FAMILY 70. HALORAGIDACEÆ. Water Milfoil Family.

232. MYRIOPHYLLUM, Lin.
587. verticillatum, Lin. Belle Isle canals. Frequent.

ORDER 25. UMBELLALES.

FAMILY 71. ARALIACEÆ. Ginseng Family.

233. ARALIA, Lin.
588. spinosa, Lin. Hercules Club. Rare.
589. racemosa, Lin. Spikenard. Belle Isle woods. Rare.

234. PANAX, Lin.
590. trifolium, Lin. Ginseng, Ground Nut. Near Palmer Park. Frequent.

FAMILY 72. UMBELLIFERÆ. Carrot Family.

235. CORIANDRUM, Lin.
591. sativum, Lin. Coriander. Waste places. Rare.

236. PASTINACA, Lin.
592. sativa, Lin. Parsnip. On Belle Isle. Common.

237. THASPIUM, Nutt.
593. trifoliatum (L.) Britt., var. aurem (Nutt.) Britt. Golden Alexander. Belle Isle woods. Common.

238. SANICULA, Lin.
594. Marylandica, Lin. Black Snakeroot. At Linden Park. Rare.
595. gregaria, Bicknell. Belle Isle woods. Common.
596. Canadensis, Lin. Belle Isle woods. Frequent.

239. FŒNICULUM, Adans.
597. Fœniculum (L.) Karst. Fennel. Waste places and on Belle Isle Frequent.

240. PIMPINELLA, Lin.
598. Anisum, Lin. Anise. On ballast grounds, etc. Rare.
599. integerrima (L.) A. Gr. Belle Isle woods. Common.

241. WASHINGTONIA, Raf.
600. Claytonia (Mx.) Britt. Sweet Cicely.
601. longistylis (Torr.) Britt.
Both are common in woods on Belle Isle.

242. CONIUM, Lin.
602. maculatum, Lin. Poison Hemlock. Waste places. Frequent.

243. SIUM, Lin.
603. cicutæfolium Gmel. Water Parsnip. Low shores on Belle Isle. Frequent.

244. ZIZIA, Koch.
604. aurea (Lin.) Koch. Golden Meadow Parsnip. Belle Isle woods. Common.

245. CARUM, Lin.
605. Copticum (L.) B. & Hk. f. Ajowan. Ballast grounds, etc. Rare.
606. Carui, Lin. Caraway. Near Linden Park. Rare.

246. CICUTA, Lin.
607. maculata, Lin. Water Hemlock. Low grounds on Belle Isle. Rare.
608. bulbifera, Lin. Shores of Belle Isle. Rare.
Both species of Water Hemlock are poisonous and produce death when eaten.

247. DERINGA, Adans.
609. Canadensis (L.) O. K. Honewort. Belle Isle woods. Common.

FAMILY 73. CORNACEÆ. Dogwood Family.

248. CORNUS, Lin.
610. florida, Lin. Flowering Dogwood. Palmer Park. Common.
611. asperifolia, Mx. Common on Belle Isle.
612. candidissima, Mill. Common on Belle Isle.

SERIES 2. GAMOPETALÆ.

ORDER 26. ERICALES.

FAMILY 74. PYROLACEÆ. Wintergreen Family.

249. PYROLA, Lin.
613. elliptica, Nutt.
614. rotundifolia, Lin. Both species near Linden Park. Rare.

FAMILY 75. ERICACEÆ. Huckleberry Family.

250. GAYLUSSACIA, H. B. K.
615. resinosa (Ait.) T. & G. Huckleberry. Near Linden Park. Rare.

251. VACCINIUM, Lin.
616. corymbosom, L., var. amœnum (Ait.) A. Gr. Blueberry. With the preceding. Rare.
617. Pennsylvanicum, Lin. Near Palmer Park. Common.
618. vacillans, Kalm. Near Linden Park. Common.

ORDER 27. PRIMULALES.

FAMILY 76. PRIMULACEÆ. Primrose Family.

252. LYSIMACHIA, Lin.
619. quadrifolia, Lin. Loosestrife. Belle Isle thickets. Rare.

253. STEIRONEMA, Raf.
620. ciliatum (Lin.) Raf. Loosestrife. Belle Isle woods. Common.
621. lanceolatum (Walt.) A. Gr. Near Linden Park. Frequent.
622. quadriflorum (Sims.) Hitchc. With the last. Common.

254. NAUMBURGIA, Mœnch. Loosestrife.
623. thyrsifolia (L.) Duby. Swampy shores of Belle Isle. Rare.

255. DODECATHEON, Lin.
624. Meadia, Lin. American Cowslip. Moist woods on Belle Isle. Rare.

ORDER 28. GENTIANALES.

FAMILY 77. OLEACEÆ. Olive Family..

256. FRAXINUS, Lin.
625. Americana, Lin. White Ash. In woods on Belle Isle. Rare.
626. Pennsylvanica, Marsh. Red Ash.
627. nigra, Marsh. Black Ash.
More or less common on Belle Isle.

FAMILY 78. GENTIANACEÆ. Gentian Family.

257. GENTIANA, Lin.
628. crinita, Frœl. Gentian. Near Linden Park. Rare.
629. alba, Muhl. *G. Andrewsii f. albiflora* Britt. In moist places and borders of woods on Belle Isle. Frequent.
630. Andrewsii, Griseb. With the preceding, but more common.

FAMILY 79. APOCYNACEÆ. Dogbane Family.

258. APOCYNUM, Lin. Dogbane.
631. androsæmifolium, Lin. Bitter-root.
632. var. incanum, A. DC.
633. cannabinum, Lin. Canadian Hemp.
634. var. glaberrimum, A. DC.
635. var. hypericifolium (Ait.) A. Gr.
636. var. pubescens (R. Br.) A. DC. All the various forms of Apocynum occur in moist or dry places, in thickets, on banks of streams, in sand or in hard dry clay. The bitter-root and its variety occur near Palmer Park; the type has the leaves smooth or nearly so underneath, but in the variety they are canescent. The Canadian Hemp and its first named variety are frequent on Belle Isle, and the other varieties near Linden Park.

FAMILY 80. ASCLEPIADACEÆ. Milkweed Family.
259. ASCLEPIAS, Lin. Milkweeds.
637. tuberosa, Lin. Pleurisy-root. Copses at Linden Park. Rare.
638. purpurascens, Lin. Near Linden Park. Frequent.
639. incarnata, Lin. Low grounds on Belle Isle and elsewhere. Common.
640. exaltata, Lin. *A. phytolaccoides* Ph. Roadsides on Belle Isle. Rare.
641. Syriaca, Lin. Fields on Belle Isle. Common.

ORDER 29. POLEMONIALES.

FAMILY 81. CONVOLVULACEÆ. Morning Glory.

260. IPOMŒA, Lin.
642. purpurea (Lin.) Roth. Morning Glory. Waste places. Frequent.

261. CONVOLVULUS, Lin.
643. arvensis, Lin. Small Bindweed. Waste places. Frequent.

262. VOLVULUS, Medic.
644. sepium (L.) Medic. Near Palmer Park. Rare.
645. var. Americanus (Sims.) *Convolvulus sepium* Lin. *var. Americanus* Sims. Bot. Mag. T. 732: 1804. On Belle Isle. Common.
646. hederaceus (Wall.) O. K., var. pubescens (Lindl.) *Calystegia pubescens* Lindl. Journ. Hort. Soc. 1. 70: 1846. A double-flowered variety of the East Indian V. hederaceus that has escaped from cultivation to waste places. The flower is composed of innumerable separate petals instead of a series of gamopetalous corollas. At a distance looks very much like a carnation.

263. CUSCUTA, Lin. Dodder.

647. Americana, Lin. *C. Gronovii* Willd. On Epilobii, Polygonii, etc., on Belle Isle. Common. The Linnean C. Americana was primarily founded upon the Gronovian plant and its habitat given as Virginia. The West Indian and South American plant was eliminated in 1818 by H. B. K. in Nova Genera et Species, etc., Vol. 3, 122, and described under the name of C. graveolens, under which name it should be known, allowing C. Americana to stand for the plant to which Linneaus intended it to apply.

FAMILY 82. POLEMONIACEÆ. Phlox Family.

264. PHLOX, Lin.

648. divaricata, Lin. Near Palmer Park. Common.
649. subulata, Lin. Sandy shores of Belle Isle. Rare.

FAMILY 83. HYDROPHYLLACEÆ. Water-leaf Family.

265. HYDROPHYLLUM, Lin.

650. Canadense, Lin. Near Linden Park. Frequent.

FAMILY 84. BORRAGINACEÆ. Borage Family.

266. CYNOGLOSSUM, Lin.

651. officinalis, Lin. Hounds-tongue. Vicinity of Linden Park. Rare.

267. LAPPULA, Mœnch. Burseed.

652. Lappula (Lin.) Karst. Waste places. Common.
653. Virginiana (Lin.) Greene. Belle Isle thickets. Common.

268. PNEUMARIA, Hill. Lungwort.

654. Virginica (Lin.) Hill. Bluebells. Low grounds on Belle Isle. Rare.

269. MYOSOTIS, Lin. Forget-me-not.

655. Virginica (Lin.) B. S. P. Scorpion-grass. Near edges of woods on Belle Isle. Rare.

270. LITHOSPERMUM, Lin.

656. arvense, Lin. Corn Gromwell. Roadsides on Belle Isle. Frequent.

FAMILY 85. VERBENACEÆ. Vervain Family.

271. VERBENA, Lin.

657. officinalis, Lin. Vervain. Waste grounds. Rare.
658. urticifolia, Lin. Roadsides near woods on Belle Isle and other places. Common.
659. hastata, Lin. The type of this species, the common blue vervain or wild hyssop, has the leaves 3-cleft at the base and is common in fields and waste places on Belle Isle and other places.
660. var. paniculata (Lam.) *V. paniculata* Lam. Ency. 8, 548: 1808. A form having none of the leaves 3-cleft. Equally common in fields and waste places.
661. var. oblongifolia, Nutt. *V. urticifolia riparia* (Raf.) Britt. In waste places and quite frequent. A form with small flowers and filiform panicles, but the bluish corollas with purplish tubes and occasionally 3-cleft leaves proves it to be a form of V. hastata rather than of V. urticifolia.
661a. angustifolia, Mx. Shore of Belle Isle. Rare.

FAMILY 86. LABIATÆ. Mint Family.

272. TEUCRIUM, Lin.

662. Canadense, Lin. Wood Sage. Marshy grounds on Belle Isle. Common.

273. SCUTELLARIA, Lin. Skullcap.
663. lateriflora, Lin.
664. galericulata, Lin. Frequent in low moist or wet grounds on Belle Isle and elsewhere.

274. MARRUBIUM, Lin.
665. vulgare, Lin. Hoarhound. Waste-grounds. Rare.

275. AGASTACHE, Clayton.
666. nepetoides (Lin.) O. K. Giant Hyssop. Belle Isle woods. Common.

276. NEPETA, Lin.
667. Cataria, Lin. Catnep. In waste places. Frequent.

277. PRUNELLA, Lin.
668. vulgaris, Lin. Heal-all. Belle Isle woods, etc. Common.

278. LEONURUS, Lin.
669. Cardiaca, Lin. Motherwort. In waste places. Frequent.

279. LAMIUM, Lin.
670. amplexicaule, Lin., var. clandestinum, Reichenb. Henbit, Dead Nettle. Waste places. Rare.

280. STACHYS, Lin.
671. asper, Mx. Hedge Nettle. Belle Isle woods. Common.

281. MONARDA, Lin.
672. fistulosa, Lin. Wild Bergamot. Near Linden Park. Rare.
673. mollis, Lin. *M. scabra* Beck. Borders of woods, etc., on Belle Isle. Common.

282. BLEPHILIA, Raf.
674. hirsuta (Ph.) Torr. Belle Isle thickets. Common.

283. HEDEOMA, Pers. Pennyroyal.
675. pulegioides (Lin.) Pers. Fields, roadsides, etc., on Belle Isle. Common.

284. CLINOPODIUM, Lin.
676. vulgare, Lin. Wild Basil. Belle Isle thickets. Common.

285. KŒLLIA, Mœnch. Mountain Mint.
677. Virginiana (Lin.) MacM. Fields on Belle Isle. Common.

286. LYCOPUS, Lin.
678. Virginicus, Lin. Bugleweed. Common in wet soils on Belle Isle.
679. rubellus, Mœnch. Water Horehound. Frequent on Belle Isle and at Linden Park.
680. Americanus, Muhl. Belle Isle in low moist grounds. Common.

287. MENTHA, Lin.
681. Canadensis, Lin. Wild Mint. Common on Belle Isle in moist soils.

288. COLLINSONIA, Lin.
682. Canadensis, Lin. Stone-root. Linden Park woods.

FAMILY 87. SOLANACEÆ. Potato Family.

289. PHYSALODES, Bœhm.
683. Physalodes, (Lin.) Britt. Apple-of-Peru. At Linden Park. Rare.

290. PHYSALIS. Ground Cherry.
684. Philadelphica, Lam. Frequent on Belle Isle.
685. heterophylla, Nees. Common at Linden Park.
686. var. ambigua (A. Gr.) Rydb. Belle Isle. Rare.

291. SOLANUM, Lin.
- 687. nigrum, Lin. Garden Nightshade. Common on Belle Isle, etc., in waste places.
- 688. Carolinense, Lin. Horsenettle. Waste grounds, etc. Frequent.
- 689. rostratum, Dunal. Bullnettle. With the preceding. Frequent.
- 690. Dulcamara, Lin. Bitter Sweet. Low grounds on Belle Isle. Rare.
- 691. tuberosum, Lin. Potato. Waste grounds. Frequent.

292. ATROPA, Lin.
- 692. Belladonna, Lin. Belladonna. Ballast and waste grounds. Frequent.

293. LYCOPERSICON, Mill. Tomato.
- 693. Lycopersicum (Lin.) *Solanum Lycopersicum* Lin. Sp. Pl. 185: 1753. Belle Isle and other places. Common in waste places.

294. LYCIUM, Lin.
- 694. vulgare (Ait. f.) Dun. Matrimony Vine. Waste places and fields. Rare.

295. HYOSCYAMUS, Lin.
- 695. niger, Lin. Henbane. Waste places. Frequent.

296. DATURA, Lin.
- 696. Stramonium, Lin. Jimsonweed.
- 697. Tatula, Lin. Thornapple. Both are common in waste places.

297. PETUNIA, Juss. Petunia.
- 698. axillaris (Lam.) B. S. P. In waste places. Frequent.

FAMILY 88. SCROPHULARIACEÆ. Figwort Family.

298. VERBASCUM, Lin.
- 699. Thapsus, Lin. Mullein.
- 700. Blattaria, Lin. Moth Mullein. Both species are common in fields and waste places on Belle Isle and other places.

299. LINARIA, Mill.
- 701. Linaria (L.) Karst. Toad Flax. Common in fields and waste places.

300. CHÆNORRHINUM, Lange.
- 702. minus (L.) Lange. Waste places. Rare.

301. ANTIRRHINUM, Lin.
- 703. majus, Lin. Snapdragon. Ballast grounds. Rare.

302. CHELONE, Lin.
- 704. glabra, Lin. Snakehead. In moist woods on Belle Isle. Common.

303. PENSTEMON, Ait.
- 705. hirsutus (Lin.) Willd. Belle Isle thickets. Rare.

304. MIMULUS, Lin.
- 706. ringens, Lin. Monkey Flower. Marsh grounds on Belle Isle. Frequent.

305. ILYSANTHES, Raf.
- 707. gratioloides (Lin.) Bth. False Pimpernell. In moist places on Belle Isle. Frequent.
- 708. attenuata (Muhl.) Small. Near Linden Park. Rare.

306. VERONICA, Lin.
- 709. scutellata, Lin. Speedwell. Belle Isle, etc., wet grounds. Common.
- 710. serpyllifolia, Lin. Roadsides on Belle Isle. Common.
- 711. peregrina, Lin. Shores of Belle Isle, etc. Frequent.
- 712. Virginica, Lin. Culver's-root. Woods on Belle Isle, etc. Common.

307. GERARDIA, Lin.
713. tenuifolia, Vahl. Fields on Belle Isle, etc. Common.
714. forma albiflora, Britt. At Linden Park. Frequent.

308. CASTILLEJA, Mutis.
715. coccinea (Lin.) Spreng. Indian Paint-brush. Frequent near Palmer Park.

309. PEDICULARIS, Lin.
716. Canadensis, Lin. Wood Betony. Louse Wort. Frequent near Linden Park.

310. MELAMPYRUM, Lin.
717. lineare, Lam. Near Linden Park. Frequent.

FAMILY 89. MARTYNIACEÆ. Unicorn-plant Family.

311. MARTYNIA, Lin.
718. Louisiana, Mill. Unicorn-plant. Waste places. Rare.

FAMILY 90. LENTIBULARIACEÆ. Bladderwort Family.

312. UTRICULARIA, Lin.
719. vulgaris, Lin. In canals on Belle Isle. Rare.

FAMILY 91. PHRYMACEÆ. Lopseed Family.

313. PHRYMA, Lin.
720. Leptostachya, Lin. Lopseed. Common in woods on Belle Isle.

ORDER 30. PLANTAGINALES.

FAMILY 92. PLANTAGINACEÆ. Plantain Family.

314. PLANTAGO, Lin. Common Plantain.
721. major, Lin. Common Plantain. Roadsides and fields on Belle Isle, etc. Common.
722. Rugellii, Dec. Shores of Belle Isle, etc. Common.
723. lanceolata, Lin. Waste places, Belle Isle, etc. Common.

ORDER 31. RUBIALES.

FAMILY 93. RUBIACEÆ. Madder Family.

315. CEPHALANTHUS, Lin.
724. occidentalis, Lin. Button-bush. Common in swampy places on Belle Isle, etc.

316. MITCHELLA, Lin.
725. repens, Lin. Patridge Berry. Near Linden Park. Frequent.

317. GALIUM, Lin. Bedstraw.
726. Aparine, Lin.
727. lanceolatum, Torr.
728. circæzans, Mx.
729. triflorum, Lin.
730. tinctorium, Lin.
731. Claytonia, Mx. All the species of Galium, except G. lanceolatum, which is rare and found only at Linden Park, are more or less common in woods, fields, etc., on Belle Isle, and also in other places that are congenial to these plants.

FAMILY 94. CAPRIFOLIACEÆ. Honeysuckle Family.

318. SAMBUCUS, Lin. Elder.
732. Canadensis, Lin. Belle Isle and other places. Common.
733. pubens, Mx. With the other species, but rare.

319. VIBURNUM, Lin.
734. cassinoides, Lin. Appalachian Tea. Common near Palmer Park.
735. lentago, Lin. Nannyberry. Near Palmer Park. Frequent.
736. prunifolium, Lin. Black Haw. Common on Belle Isle.

320. TRIOSTEUM, Lin.
737. perfoliatum, Lin. Feverwort. Near Linden Park. Frequent.

321. LONICERA, Lin. Honeysuckle.
738. glaucescens, Rydb.
739. dioica, Lin. Both species are frequent near Palmer Park.
740. Xylosteum, Lin. An escape from cultivation. Waste places. Rare.

FAMILY 95. DIPSACACEÆ. Teasel Family.

322. DIPSACUS, Lin.
741. fullonum, Lin. *D. sylvestris* Huds. Wild Teasel. Common in fields and waste places, Belle Isle, etc.

ORDER 32. CAMPANULALES.

FAMILY 96. CUCURBITACEÆ. Gourd Family.

323. CUCURBITA, Lin. Squash.
742. Pepo, Lin. Pumpkin.

324. CUCUMIS, Lin.
743. Melo, Lin. Muskmelon.

325. COLOCYNTHIS, Tourn. ex. Quer.
744. Citrullus (Lin.) O. K. Watermelon. These three gourds are frequently found upon ballast grounds and in waste places.

FAMILY 97. CAMPANULACEÆ. Bellflower Family.

326. CAMPANULA, Lin.
745. aparinoides, Ph. Marsh Bellflower. Marshy grounds on Belle Isle. Common.

327. SPECULARIA, Heist. ex. Fabr.
746. perfoliata (Lin.) A. DC. Venus' Looking-glass. Frequent in thickets on Belle Isle.

FAMILY 98. LOBELIACEÆ. Lobelia Family.

328. LOBELIA, Lin.
747. cardinalis, Lin. Cardinal flower. Near Linden Park. Rare.
748. syphilitica, Lin. Blue flower. Moist woods on Belle Isle. Common.
749. forma albiflora, Britt. With the species. Common.
750. spicata, Lam. Near Linden Park. Frequent.
751. var. hirtella, A. Gr. Near water works. Frequent.
752. inflata, Lin. Indian Tobacco. Borders of woods on Belle Isle. Rare.

FAMILY 99. COMPOSITÆ. Composite Family.

329. VERNONIA, Schreb.
753. Drummondii, Shuttlew. Iron-weed. Common on Belle Isle and also on main land.
754. gigantea (Walt.) Britt. Fireweed. Belle Isle. Rare.

330. EUPATORIUM, Lin.
755. purpureum, Lin. Queen-of-the-Meadow. Vicinity of Linden Park. Rare.
756. perfoliatum, Lin. Boneset. Common in wet places on Belle Isle.

331. LACINARIA, Hill. Blazing Star.
757. scariosa (Lin.) Hill., var. corymbulosa, Sheldon. Near Palmer Park. Frequent.

332. SOLIDAGO, Lin. Goldenrod.
758. bicolor, Lin. White Goldenrod. Linden Park. Common.
759. speciosa, Nutt. Near Linden Park. Rare.
760. rugosa, Mill. Near Linden Park and Palmer Park. Common.
761. juncea, Ait., var. scabrella (T. & G.) A. Gr. With the last. Rare.
762. serotina, Ait. Low grounds near water works. Rare.
763. var. gigantea (Ait.) A. Gr. With the last. Rare.
764. Canadensis, Lin., var. scabriuscula, Porter. On Belle Isle. Frequent.
765. nemoralis, Ait. Linden Park. Common.
766. Riddellii, Frank. Near Linden Park. Common.
767. graminifolia (Lin.) Ell. Belle Isle, etc. Common.

333. ASTER, Lin.
768. cordifolius, Lin. Linden Park. Common.
769. sagittifolius, Wedm., var. urophyllus (Lindl.) Burgess. Belle Isle, Linden Park. Common.
770. Novae-Angliae, Lin. Belle Isle, etc. Common.
771. var. roseus (Desf.) A. Gr. Near the water works. Rare.
772. oblongifolius, Nutt. (?) Near Linden Park. Frequent.
773. amethystinus, Nutt. (?) Near the water works. Rare.
774. puniceus, Lin., var. lucidulus, A. Gr. On Belle Isle. Frequent.
775. var. firmus (Nees.) T. &. G. Near Palmer Park. Frequent.
776. lævis, Lin. Dry soils on Belle Isle and elsewhere. Common.
777. var. lævigatus, A. Gr. Belle Isle, etc. Frequent.
778. var. amplifolius, Porter. Linden Park. Common.
779. Novae-Belgii, Lin. (?) Linden Park. Frequent.
780. salicifolius, Lam. Belle Isle. Frequent.
781. paniculatus, Lam. Swampy shores of Belle Isle. Common.
782. var. bellidifolius (Willd.) Burgess. Belle Isle. Common.
783. Tradescanti, Lin. Swampy shores of Belle Isle. Common.
784. ericoides, Lin. Near water works. Rare.
785. var. platyphyllus, T. & G. Near water works. Frequent.
786. lateriflorus, Lin. Belle Isle. Common.
787. var. thrysoideus (T. & G.) Burgess. Belle Isle. Common.
788. var. grandis, Porter. Belle Isle. Rare.
789. var. horizontalis (Desf.) Burgess. Belle Isle. Common.
790. var. hirsuticaulis (Lindl.) Porter. Belle Isle. Rare.
791. multiflorus, Ait. Belle Isle and elsewhere. Common.
792. umbellatus, Mill. Near Linden Park, etc. Frequent.

334. ERIGERON, Lin. Fleabane.
793. Philadelphicus, Lin.
794. annuus (Lin.) Pers.
795. ramosus (Walt.) B. S. P.
796. Canadensis, Lin.
797. divaricatus, Mx.

With the exception of the last named, which is rare, and found only at Linden Park, the species of Erigeron are more or less common in fields and along roadsides, etc., on Belle Isle and the main land also.

335. ANTENNARIA, Gærtn. Cudweed.
798. neodioica, Greene., var. attenuata, Fernald. Near Linden Park. Rare.
799. neglecta, Greene. Common on Belle Isle and the main land also.
800. occidentalis, Greene. Linden Park and Palmer Park. Frequent.
801. fallax, Greene. Linden Park and Palmer Park. Frequent.
802. arnoglossa, Greene., var. ambigens, Greene. Linden Park and Palmer Park. Frequent.

336. GNAPHALIUM, Lin.
803. obtusifolium, Lin. Life Everlasting. On Belle Isle. Common.
804. uliginosum, Lin. On Belle Isle. Frequent.
805. purpureum, Lin. At Linden Park. Rare.

337. SILPHIUM, Lin.
806. laciniatum, Lin. Rosinweed.
807. terebinthinaceum, Jacq.
Both species of Rosinweed are frequent near Linden Park.

338. AMBROSIA, Lin. Ragweed.
808. trifida, Lin. Waste places. Common.
809. artemisiæfolia, Lin. Common on Belle Isle.

339. XANTHIUM, Lin. Cocklebur.
810. spinosum, Lin. Waste places. Rare.
811. strumarium, Lin. Waste places, also Belle Isle. Frequent.
812. Canadense, Mill. Shores of Belle Isle. Common.
813. var. echinatum (Murr.) A. Gr. Linden Park. Frequent.

340. HELIOPSIS, Pers.
814. scabra, Dun. Dry grounds on Belle Isle. Rare.

341. RUDBECKIA, Lin.
815. hirta, Lin. Yellow Daisy. Fields, etc., on main land. Common.

342. HELIANTHUS, Lin. Sun-flower.
816. annuus, Lin. Waste grounds at Detroit. Common.
817. Maximiliani, Schrad. Waste grounds. Rare.
818. giganteus, Lin. Belle Isle, etc. Common.
819. hirsutus, Raf. On main land. Rare.

343. COREOPSIS, Lin.
820. tinctoria, Nutt. Tickseed. A form with small heads and with rays yellow throughout. Waste places. Rare.
821. tripteris, Lin. Moist thickets near Palmer and Linden Parks. Common.

344. BIDENS, Lin. Bur marigold, Beggar ticks.
822. cernua, Lin. Common and variable. Belle Isle, etc.
823. var. Bidens (Lin.) *Coreopsis Bidens* Lin. Sp. Pl. 908: 1753. *Bidens cernua var. elliptica* Wiegand. Belle Isle. Rare.
824. connata, Muhl. Belle Isle, etc. Common and variable: leaves undivided, incisely-cut or serrate (the type); or pinnately three divided with the terminal division petioled,—
825. var. petiolata (Nutt.) *B. petiolata* Nutt. Jour. Acad. Philad. 7, 99:
826. in. var. anomala, the awns are upwardly barbed.
827. comosa (A. Gr.) Wiegand. Belle Isle and on the main land. Common.
828. melanocarpa, Wiegand. Belle Isle and on the main land. Common.
829. frondosa, Lin. Belle Isle, etc. Common.
830. var. puberula, Wiegand. On the main land. Common.
831. trichosperma (Mx.) Britt., var. tenuifolia (A. Gr.) Britt. (?) A peculiar form found on Belle Isle. It has the outer linear involucre bracts twice longer than the inner and equal to the rays in length.
832. aristosa (Mx.) Britt. Belle Isle. Rare.

345. HELENIUM, Lin.
833. autumnale, Lin. Sneezeweed. Common in woods on Belle Isle.

346. ACHILLEA, Lin.
834. Millefolium, Lin. Yarrow. Borders of woods on Belle Isle. Frequent.

347. ANTHEMIS, Lin.
835. Cotula, Lin. Mayweed. Waste places, ballast grounds, Belle Isle. Common.

348. CHRYSANTHEMUM, Lin.
836. Leucanthemum, Lin. Ox-eye-daisy. Fields at Linden Park, Belle Isle, etc. Common.

349. TANACETUM, Lin.
837. vulgare, Lin. Tansy. Waste places, etc. Frequent.

350. ARTEMISIA, Lin. Wormwood.
838. annua, Lin. Waste grounds. Common.
839. biennis, Willd. Belle Isle. Common.
840. vulgaris, Lin. Waste places. Frequent.

351. ERECHTITES, Raf.
841. hieracifolia (L.) Raf. Fireweed. Marshy grounds on Belle Isle. Common.

352. SENECIO, Lin.
842. aureus, Lin. Life-root. In moist grounds on Belle Isle. Frequent.
843. Balsamitæ, Muhl. Near Palmer Park. Frequent.
844. vulgaris, Lin. Groundsel. Waste places. Rare.

353. CALENDULA, Lin.
845. officinalis, Lin. Fetid Marigold. Waste places. Rare.

354. ARCTIUM, Lin.
846. minus, Schk. Burdock. Belle Isle, etc. Common.

355. CARDUUS, Lin. Thistle.
847. lanceolatus, Lin. Bull Thistle. Fields on Belle Isle and main land. Rare.
848. discolor (Muhl.) Nutt. Field Thistle. Fields, etc. Frequent.
849. arvensis (Lin.) Robs. Canada Thistle. Belle Isle and main land. Common.

356. ONOPORDON, Lin.
850. Acanthium, Lin. Scotch Thistle. Waste places. Rare.

357. CENTAUREA, Lin.
851. Cyanus, Lin. Corn Flower. An escape from gardens into waste places. Not very frequent.

358. CICHORIUM, Lin.
852. Intybus, Lin. Chicory. Waste places, Belle Isle, etc. Common.
853. var. divaricatum, DC. Near water works. Frequent.

359. ADOPOGON, Neck.
854. Virginicum (Lin.) O. K. Goatsbeard. Near Linden Park. Common.

360. TARAXACUM, Hall.
855. Taraxacum (Lin.) Karst. Dandelion. Fields on Belle Isle, etc. Common.

361. CICERBITA, Wallr. *Mulgedium* Cass.
856. Floridana (Lin.) Wallr. Borders of moist woods on Belle Isle. Rare.
857. Canadensis (Lin.) *Sonchus Canadensis* Lin. Sp. Pl. 793: 1753 (exclude discription). On Belle Isle and other places. Common.
858. var. integrifolia (T. & G.) *Mulgedium leucophæum var. integrifolium* T. & G. Flora ii, 499: 1843. Belle Isle and near Palmer Park. Rare.

362. SONCHUS, Lin.
859. arvensis, Lin. Sow Thistle. Ballast grounds, etc. Frequent.
860. oleraceus, Lin. Belle Isle, etc. Common in waste places.
861. asper (Lin.) Hill. Belle Isle, etc. Common in waste places.

363. LACTUCA, Lin. Lettuce.
862. sativa, Lin. Garden Lettuce. Occasionally a specimen of this species is found on the Island, also on the main land in waste places.
863. Scariola, Lin. Common in waste places, also Belle Isle.
864. Canadensis, Lin. Belle Isle and elsewhere. Common.
865. hirsuta, Muhl. Near Linden Park. Frequent.
866. sagittifolia, Ell. Belle Isle. Common along the shores.
867. pulchella (Ph.) DC. Waste places. Rare.

364. PRENANTHES, Lin. Rattlesnake-root.
868. altissima, Lin. Near Palmer Park. Frequent.
869. alba, Lin. Common on Belle Isle.

365. HIERACIUM, Lin.
870. scabrum, Mx. Hawkweed. Linden Park. Frequent.

INFECTIOUSNESS OF MILK OF TUBERCULOUS COWS.

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In this paper it is my purpose to place on record the results of a few observations, to present new groupings of facts previously recorded, placing them in such connection with each other and with new ones as to reenforce conclusions formerly held, but now weakened and, in the minds of some persons, destroyed by what I consider wrong interpretations of facts, some of which have been recently observed; also to present a few conclusions which seem to call for legislative and other action.

Dr. G. Sims Woodhead, the eminent bacteriologist and pathologist, has said:

"That tuberculosis could be produced by the ingestion of tuberculous matter into the lower animals has been inferred since Jacobi's case of tuberculosis in a dog, which had been in the habit of ingesting the expectorations of a phthisical patient. Klebs, Chauveau, Gerlach, and Orth, early in the controversy, claimed to have proved, by actual experiment, that the milk, flesh, and caseous material from cattle affected with tuberculosis would, when introduced alone or along with other food into the alimentary canal of rabbits, etc., give rise to tuberculosis in the pharynx, in the lymphatic glands of the neck, the stomach, intestine, omentum, liver, and spleen, and then later in other organs. Further, in 1884, Bang, at the Copenhagen International Medical Congress, made known the results of experiments on the milk from tuberculous cows, in which he was able to demonstrate the presence of numerous tubercle bacilli. Taking these two factors in turn, one cannot but be struck by the difference of opinion, as regards the occurrence of abdominal tuberculosis in children, held and expressed by physicians, on the one hand, and by those who have frequent opportunities of making examinations of the bodies of young patients who have succumbed to some form or other of tuberculosis, on the other."*

So long as no such microörganism as the bacillus tuberculosis had ever been found growing under natural conditions outside of a living animal body, it was not difficult to believe that that bacillus was not now a saprophyte, but universally, at the present time, a parasite; and generally living in warm-blooded animals only. But since the discovery of several other species of microörganisms similar to the bacillus tuberculosis, and especially since the discovery of such an organism on timothy hay, it has been common among persons who, although not leaders in sanitary sciences, yet are leaders in other lines of thought, to find doubts expressed by them as to the bacillus tuberculosis being the sole specific cause of tuberculosis, in animals and in man, and especially as to its being a strictly parasitic microörganism.

There seem to me to be sufficient facts to enable us to come to a positive conclusion on this subject. Let us briefly consider a few of these facts.

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* Laboratory Reports, Royal College of Physicians, Edin. Vol. I, pp. 180-1.

A summary of results of an experiment in Denmark reported by Professor Bang is as follows:

"Whole herd of 208 (milch cows) tested in spring, 1892, reacted [to tuberculin test] 80 per cent." The seventy healthy cows, that did not react, were then separated from the infected animals. Whether or not there was any thorough disinfection of the premises and pastures to be occupied by the healthy cows, I am not informed; but the further tests spring and autumn for three years resulted as follows:

Sound herd of 70 tested in autumn, 1892, reacted 10 per cent.
Sound herd of 103 tested in spring, 1893, reacted 10 per cent.
Sound herd of 107 tested in autumn, 1893, reacted 1 per cent.
Sound herd of 122 tested in spring, 1894, reacted 1.6 per cent.
Sound herd of 119 tested in autumn, 1894, reacted 1 per cent.
Sound herd of 136 tested in spring, 1895, reacted 2 per cent.

"Here is a large herd in which 80 per cent of the milch cows reacted. * * * After separation, the test was carried out twice a year, and the stock augmented, chiefly by breeding. The sound herd remained practically sound (only 1 or 2 per cent reacting at each test), and at the end of three years the sound herd is about double in size.—*Sanitary Journal*."*

Separation of healthy animals from infected animals would not be sufficient to prevent the disease from attacking the healthy animals, if the timothy bacillus, or any other microörganism not parasitic on animals could cause tuberculosis.

The University of Wisconsin Agricultural Experiment Station Bulletin No. 78, for August, 1899, is "The History of a Tuberculous Herd of Cows." It is an extremely valuable document, tending to prove: 1, that tuberculosis is not inherited by calves of tuberculous cows; 2, that it is communicable; and 3, that calves from tuberculous cows if fed on uninfected milk, and kept away from infected animals, do not contract tuberculosis. Briefly that part of the history which I wish to present to you is as follows: In 1891 a farmer bought some blooded stock, whereby it appeared that tuberculosis was introduced into his herd. In 1895 tuberculin tests revealed the fact that 13 out of 16 mature animals had tuberculosis. Every breeding animal in his herd except two were tuberculous. The question arose whether it was possible to build up a healthy herd of the blooded stock without destroying the tuberculous animals. The animals were separated into two herds, one infected, one uninfected. The barn was cleared of all litter, disinfected, a partition of one thickness of boards was made across the barn, the infected animals were all kept in one end, the uninfected in the other end of the barn. The two herds were not pastured in the same fields. Although kept on the same farm where previously the disease had spread, in the same barn, separated, however, by a partition, and subject to the same food and climatic conditions as before, there was no further spread of the disease after the separation of the infected from the uninfected; thus proving conclusively that the disease was not previously spread by any timothy bacillus, or by any other thing whatever except directly or indirectly from the infected animals.

* Ohio Sanitary Bulletin, Vol. 1, 1897, page 89.

Further, the calves dropped by the infected cows were at once removed, fed on boiled milk, and later put with the uninfected herd; and in every instance the calves remained free from tuberculosis; thus proving that those tuberculous cows did not transmit tuberculosis to their offspring.

"*Fifth tuberculin test.* In February, 1899, a final round-up test of the entire herd was again made as the increase in progeny again necessitated the sale of some of the stock. This test gave the same general results as before, there being no increase in the disease whatever.

"In order to present the actual figures showing the rate of herd increase, the results of the different tuberculin tests are summarized in the following table. These figures include the status of the herd at the different testing periods, but do not take into consideration the young calves which were not raised.

TABLE I.—*Record of repeated tuberculin tests made on a herd in which the progeny of reacting animals was separated from dams at birth.*

Date of test.	No. of animals adjudged by test as		No. of animals in	
	Healthy.	Affected.	Healthy section reacting to subsequent tests.	Affected section not reacting to subsequent tests.
January, 1896	18	16	....	....
May, 1896	21	14	0	0
April, 1897	30	13	0	0
February, 1899	64	7	0	0

* * * "The fact that since this experiment was begun, every calf born in the herd has been free from tuberculosis is brought out forcibly" * * * by the diagram not here reproduced. "In the majority of cases where bull calves were dropped, they were disposed of as veal," * * * "It is of course possible that these animals might have acquired tuberculosis later, but the fact that they were born free from the disease, and remained so for several months before the test was made, indicates that it is possible to raise a healthy calf from an affected mother in the great majority of cases." * * *

"The method here followed has come to be known as the Danish method, because under the energetic leadership of Prof. Bang, the government veterinarian, it has been thoroughly tried in Denmark. Bang's numerous experiments indicate that the disease can be 'weeded out' in a practical manner. At the present time the Danish law is such that the government supplies the tuberculin and makes the test gratis, provided the owner will separate his herd on the basis of the results of the test. The sale of reacting animals is prohibited except for immediate slaughter, which must be done under authorized veterinary control, the

meat being used under certain restrictions, if not wholly condemned. Owing to the extensive spread of the disease among Danish cattle, all skim milk returned to the farm must be heated to a temperature that will surely destroy the tubercle bacilli. Since the introduction of this regulation, the percentage of the disease in calves has fallen from 15.5 per cent in 1895 to 10.6 per cent in the years 1896 to 1898." In other words, the disease has been decreased by about one-third; which is further evidence that tuberculosis in cattle can be restricted, because it actually has been restricted by lessening the use of infected milk of tuberculous cows.

"The results of Bang's tests were recently presented to the Congress for the Study of Tuberculosis (Paris, 1898). In the case of twenty-three herds there reported, none were so successfully controlled as in the instance here detailed. In every herd in which he tried this method, a varying number of animals were found that reacted positively to subsequent tests. These partial failures, amounting in all cases to about twelve per cent, he attributes to carelessness in maintaining complete separation of reacting from healthy herds."*

In a recent number of the London Lancet is a summary statement of evidence of the infectiousness of tuberculous milk, which is so condensed that I use a portion of it here.

"Numerous bacteriological examinations of milk during the last ten years have proved the presence of tubercle bacilli in a greater or less percentage; for example, in Berlin milk by Obermüller† to the extent of 61 per cent, and by Petri,‡ also in Berlin milk, only of 14 per cent—using the method of inoculation of animals as the test. Also Rabinowitsch and Kempner§ found that 28 per cent of 25 samples of Berlin milk contained tubercle bacilli.

"In the medical officer of health's report¶ to the Liverpool Health Committee on the question of tubercle bacilli in the milk supply of Liverpool 2.8 per cent of the 144 samples collected from sources within the city were proved to be infective by experiments of Professor Sims Woodhead, Professor Boyce, and Professor Delépine, while 29.1 per cent of 24 samples taken on arrival from parts of Cheshire, Shropshire, etc., at the railway stations were found to be tuberculous. Similarly Professor Delépine‖ reports of the milk supplies of Liverpool, Manchester, and other parts, 5.55 per cent of 54 samples collected from town dairies, and 17.6 per cent of 125 samples of milk from country farms collected at the railway stations proved to be tuberculous. Again, milk collected from 16 Cambridgeshire dairies, a sample from each, was reported by Kanthack and Sladen** to have produced tuberculosis in guinea-pigs on inoculation to the extent of 56.3 per cent of the milk (nine samples).

"Professor Boyce * * * has carried on numerous experiments during the last two years for the health committee of the corporation of Liverpool. During the year 1898, 84 samples of 'town' milk, of which

* *The History of a Tuberculous Herd of Cows,* University of Wisconsin, Agricultural Experiment Station, Bulletin No. 78, pp. 9-10, 15.
† Hygienische Rundschau, 1895, No. 19.
‡ Arbeiten aus dem Kaiserlichen Gesundheitsamte, 1898, Vol xiv.
§ Rabinowitsch and Kempner: Zeitschrift für Hygiene, 1899, p. 137.
¶ Report and Brit. Med. Jour., 1897, Vol. ii, p. 162.
‖ Brit. Med. Jour., 1898, Vol. ii, p. 917.
** The Lancet, Jan. 14th, 1899, p. 74.

seven (=8.3 per cent) proved to be tuberculous on guinea-pig inoculation, and 28 samples of 'railway' or 'country' milk, of which five (=17.8 per cent) were infective, were examined, while during 1899 to the end of June, of 75 samples of 'town' and 63 samples of 'railway' milk 6.6 per cent of the former and 17.4 per cent of the latter proved to be tuberculous. These results indicate the effects (as compared with country places) of better sanitation in the cowsheds, shippons, and dairy premises in large towns, enforced by local by-laws ensuring better ventilation, spacing, cleanliness, and regular inspection."*

* * * * * *

Going back now and beginning at a time before the discovery of the bacillus,—"In 1880 Bollinger† by inoculation experiments found the milk of a cow with tuberculosis of the udder to be infective, as also that of another case of tuberculosis without lesion of the udder. * * * Hirschberger‡ asserts from his experiments (20 cases with 11 positive results) that milk may be infective when only a small lesion occurs in the lung. Ernst§ examined 114 samples of milk from 36 tuberculous cows showing no udder lesion and 28.57 per cent proved to be infective; Smith and Schröder¶ found the milk infective in two cases out of six tuberculous animals with no udder lesion, and Schröder later found the same in two samples of milk from 31 tuberculous cases. Delépine|| proved the presence of tuberculosis in the milk of two cases out of six which had reacted to tuberculin and showed clinically more or less evidence of the disease. In these two cases the udders showed lesions microscopically. Later he examined the milk of 24 suspicious udders"** with the result that samples of milk of the 10 cows whose udders were "certainly diseased," 5 or 50 per cent produced tuberculosis; and of the 9 "probably diseased," 1 or 11.1 per cent produced tuberculosis; while of the samples of milk from five "healthy" cows, none produced tuberculosis.**

At the recent meeting of the Michigan State Veterinary Medical Association, February 6, 1900, a prominent member from Detroit mentioned that he had been called by a leading citizen of Detroit because of the death of a number of Jersey calves. Because of his knowledge that tuberculous cows lose their calves, the veterinarian suspected tuberculosis in the cows, and tested them. Of 27 fine looking cows 13 reacted to the tuberculin test, and were, therefore, tuberculous; and of the 13, nine had lost calves; post-mortem examination of the dead calves revealed tuberculosis as the cause of death. Fourteen calves 7 to 14 weeks old died in that herd, which was supplying milk to the people of Detroit. Only about half the cows in that herd were tuberculous; therefore the tuberculous milk would perhaps be diluted with an equal quantity of uninfected milk; but if so deadly to the calves, should it not, even if mixed with an equal amount of uninfected milk, be rejected as food for human infants?

* Lancet, London, Jan. 20, 1900, pp. 159-160.—H. E. Annett, M. D., Vict. D. P. H.
† Aerztliches Intelligenzblatt, 1880, p. 409.
‡ Archiv für Klinische Medicin, 1889.
§ American Journal of the Medical Sciences, November, 1889.
¶ U. S. Dept. of Agri., Bureau An. Ind.; Bull. 3, 1893, p. 60; Bull. 7, 1894, p. 75.
|| Journal of Comparative Pathology, 1897, p. 192.
** Lancet, London, Jan. 20, 1900, p. 160.

Deaths of children and other persons from tubercular disease caused by infected milk.

A most convenient list of instances of this nature is in the annual report of the New Hampshire State Board of Health, Vol. 13, 1895, pp. 37-39. The author says: "There is reason to believe that countless thousands of deaths have occurred due to this source of infection, which have not been thus ascribed and of which no record has been made." * * * "The following are some of the authenticated cases of accidental infection which have come to our notice. It is not to be inferred that they are of necessity all or the strongest on record."

"Dr. Anderson of Seeland reports a case of a babe fed on the milk of a cow having tuberculosis of the udder. The child died at six months with tuberculosis. The mother also developed symptoms of the disease after the child's birth. It was considered that both contracted the disease from the cow's milk.*

"Ollivier,† at a meeting of the Academie de Medicine of Paris, stated that a patient of his, a young woman twenty years old, of vigorous health and without constitutional trouble, had acute tubercular meningitis (inflammation of the membranes of the brain of tubercular origin). She had been educated at a boarding school where thirteen pupils had been ill of, and six had died of tuberculosis within a few months. The milk supplied to the school was from cows kept on the place. Upon examination these animals were found to have tubercular ulcers on their udders, and after being slaughtered were found to be generally tuberculous.

"A Scotch family, all of sturdy health, had a herd of cattle which developed tuberculosis. Two daughters, being young, were brought up on the milk. Their two older brothers were more found of whisky than of milk. They are living, healthy and hearty, while their two sisters are lying in their graves, victims of tuberculosis.‡

"In the practice of Dr. Stang, of Amorback, a well-developed five-year-old boy from sound parents, whose ancestors on both sides were free from hereditary taint, succumbed after a few weeks' illness with acute miliary tuberculosis of the lungs and enormously enlarged mesenteric glands. A short time before the parents had their family cow killed and found her the victim of advanced pulmonary tuberculosis.§

"Dr. Demme records the cases of four infants in the Child's Hospital at Berne, the issue of sound parents, without any tuberculous ancestry, that died of intestinal and mesenteric tuberculosis, as the result of feeding on the unsterilized milk of tuberculous cows.¶ * * *

* * * "A comparatively strong and healthy child of twenty-one months, visited his uncle for a week. While there he drank the unsterilized milk of a cow which was soon after condemned and killed in a state of generalized tuberculosis. A few weeks after his return the child began to fail and died three months after the fatal visit, a mere skeleton, with tabes mesenterica, or consumption of the bowels." * *

* Hatch Exp. Station of Mass. Ag'l. College, Bul. No. 3, p. 15.

† Bacteriological World, Aug. '91, translated from Allgem. Med. Cent. Zeit.: also la Semaine Medical, Paris, Feb. 25, 1892.

‡ Discussion on Tuberculosis, Meeting Nat. Vet. Ass'n., London, May, '83. Extracted from Lecture to Md. Sanitary Council by Dr. Robt. Ward, 1886, p. 10.

§ Law: Cornell University Exp. Stat. Bul. No. 65, p. 137.

¶ Law: Cornell University Exp. Stat. Bul. No. 65, p. 137.

"A second child brought up on* sterilized milk is in robust health. Both parents are in excellent health.

"A child four years old, great grandson of Henry Ward Beecher, died last March [1893] at Yonkers, N. Y., of tubercular meningitis. The diagnosis was confirmed by specialists. There were no hereditary tendencies to the disease known. The certainty that he had the disease, and the inability to account for it from human agencies led the physicians to suspect the milk of two Alderney cows, on which the child had been mainly fed. Both the tuberculin test and the post-mortems showed that both animals were tuberculous.† * * *

"May 30, 1879, a cow died of generalized tuberculosis in Providence, R. I., the lungs, most of the abdominal viscera, muscular tissue, and udder being tuberculous. The milk had been used in the family. In August the baby was taken sick and died in seven weeks of tubercular meningitis. Post-mortem showed tubercular deposits in the membranes covering the brain, and some in the lungs. Two years later a two-year-old child in the same family died of tubercular bronchitis and seven years later a nine-year-old boy, 'delicate' for years, died of 'quick' consumption. So far as known the family on both sides were rugged and healthy.‡

"Dr. H. M. Pond§ reports four cases of tuberculosis in one family, of which three were fatal. He considered the milk of their cows to be the source of the disease, since those animals were apparently tuberculous.

"In the spring of 1890 Dr. Gage, city physician of Lowell, Mass., had as a patient an infant which died of tubercular meningitis. Its parents were healthy, and surroundings good. It had never been fed anything but the milk of a single cow. The cow's milk was microscopically examined and found to contain the bacilli of tuberculosis. Guinea pigs inoculated with her milk developed the disease. A second child fed upon the same milk was developing similar symptoms to those discovered in the child that died."

Deaths from tubercular disease of bowels, and general tuberculosis, including meningitis, occur at milk-drinking ages.

Dr. G. Sims Woodhead says:

"For example, tubercular meningitis occurs much more frequently between the third and eighth years than it does at any other period of life. Rilliet and Barthez, giving the results of the examination of 98 cases of this condition, state that during the first year there were only 2 cases; between one and two years and a half, 17; from three to five years and a half, 34; from six to seven years and a half, 23; from eight to ten years, 15; and from eleven to fifteen years, 7 cases.

"Of 54 cases of tubercular meningitis I have examined, not one was under one year (adopting the same classification); between one and two years and a half there were 15; from three to five years and a half, 21; from six to seven years and a half, 8; from eight to ten years, 8; and

* Private letter to J. L. H.; also reported by Law, *ibid.*, p. 137.
† N. Y. Sun, March 29, '94. Also private letters to J. L. H.
‡ Ernst: Report to Mass. Soc. Promot. Agt., p. 4; also reprint in Hatch Exp. Stat. of Mass. Ag'l. College, Bul. No. 8, p. 16.
§ Pacific Med. and Surg. Jour., 1888.

from eleven to fifteen years, 2. These figures correspond fairly closely with those given by Rilliet and Barthez, and might serve as a basis for comparison.

* * * "Intestinal tubercle, again, is said to be most common in the years following childhood, from twelve upwards, for six or seven years. From an analysis of 127 cases of tuberculosis in children it was found that in 43 instances there was tubercular ulceration of the intestine. During the first year after birth there was only 1; between one and two years and a half, 14; from three to five years and a half, 10; from six to seven years and a half, 7; from eight to ten years, 5; and from eleven to fifteen years there were 6. In this series of cases, then, the intestines are frequently affected during very early life, as well as in somewhat later years, but although the intestines are directly affected by tubercle in such a small proportion of cases, the mesenteric glands are found to be in some stage or other of tubercular degeneration in no less than 100 instances, or in nearly 79 per cent of the whole. This I consider to be a point to which special attention should be paid, as it seems, to me, to shed a flood of light on the subject of tuberculosis in children. The age at which these tubercular glands in the mesentery were found is also significant. During the first year of life there were 4 cases; from one to two years and a half, 33; from three to five years and a half, 29; from six to seven years and a half, 12; from eight to ten years, 13; and from eleven to fifteen years, 9 cases. Here, again, it will be noted the figures are higher during the earlier periods than during later years, but the maximum is reached (as with ulceration of the intestine) at a distinctly earlier period than in the case of tubercular meningitis. In 14 cases the mesenteric glands only were affected—*i. e.*, there was no tubercle found in any other part of the body."*

My own observation of the vital statistics of Michigan is that, as a rule, in all years except when meningitis is epidemic, in which instances the disease is most prevalent in the spring, that is, following several weeks after the time of the exposures to greatest cold, and the increase is undoubtedly due to the entrance of the specific germs by way of the air passages, in other years meningitis is most prevalent in August, following the time of warmest weather. My belief is that the increase in meningitis at that time and which occurs among children at and immediately following the milk-drinking ages, is in some way connected with changes which occur in the milk because of the heat. And one of the purposes of this paper is to present this view in order that evidence on this important practical point may hereafter be accumulated by bacteriologists and others. One distinct question is: Do tubercle bacilli multiply *in milk* at temperatures of the atmosphere common in July and August? At least, I suppose we may safely assume that milk will maintain the animal heat longer in hot weather than in cold weather. And "Koch states that between 86° and 105° F. tubercle bacilli grow, but that outside these limits it is exceedingly difficult to obtain a growth."† Our hottest weather in summer is well within these limits, being from 90° to 100° F.

* Laboratory Reports, Royal College of Physicians, Edin., Vol. I, pp. 181-2.
† Laboratory Reports, Royal College of Physicians, Edin., Vol. I, p. 193.

And, if the *increase* of the meningitis is due to *increase* of pathogenic microörganisms in the milk, then the ordinary amount of meningitis may also be due to pathogenic microörganisms in the milk. An important question, which I wish to put before members of the Academy for investigation, is—What proportion of the meningitis in Michigan is caused by infectious milk of tuberculous cows?

Tuberculous women do not usually have tuberculosis of the mammary gland; and Prof. Bang says that in "inoculation experiments made with milk coming from eight phthisical women, although all these women were affected with advanced tuberculosis, I never found the milk virulent."*

Dr. Sims Woodhead says: "Anyone who has worked at the subject will have been struck by the fact that although tuberculosis in the human subject is so frequently met with in young married women, tubercular mammitis is extremely rare,—so rare in fact that Dr. D. Hubermaas† was able to collect and record only some eight cases. In cattle, on the other hand, where the mammary gland carries on its functions under conditions which are far from healthy, or at any rate far from normal, this tubercular mammitis is not by any means of infrequent occurrence."‡

Inasmuch as it appears probable that ordinarily much of the meningitis is caused by specific germs which gain entrance to the bodies of the children by way of the alimentary canal, and as mother's milk is seldom infected with tubercle bacilli, and cow's milk is known not infrequently to be so infected, it seems reasonable to believe that meningitis may be lessened by measures to restrict the use of unsterilized milk of tuberculous cows.

CONCLUSIONS.§

1. Milk of tuberculous cows is liable to be infected with tubercle bacilli.
2. Milk is especially liable to be infectious when from a cow that has tubercular disease of the udder.
3. Milk infected with tubercle bacilli is known to cause the death of calves fed on it. Also the death of pigs fed on it.*
4. There is reason to believe that milk infected with tubercle bacilli causes the death of many children, and tubercular disease of many other children, fed on such milk. The great proportion of deaths from tubercular disease of the bowels, and from tubercular meningitis, in children at the ages when usually fed on cow's milk, is corroborative evidence of this.
5. Tuberculosis is not usually transmitted from cow to calf by heredity.
6. At the present time tuberculosis is not caused by the timothy bacillus, nor by any saprophyte; the disease is caused by the bacillus

* Congress pour l'Etude de la Tuberculose chez l'homme et chez les animaux, Paris, France, 1888, Premier Fascicule, pp. 69-72.

† Beitrage zur klin. chir. Mitth. aus der-chir. Klinik zur Tubingen Band ii, Heft 2.

‡ Laboratory Reports, Royal College of Physicians, Edin., Vol. 1, pp. 186-187.

§ These conclusions have a much broader basis than the facts mentioned in this brief paper; the literature and data in the library and office of the State Board of Health are very extensive.

tuberculosis which is a true parasite; and the disease is spread (directly and indirectly) only from infected animals and persons.

7. Tuberculosis in cows is easily restricted.

8. As a measure of pecuniary economy to citizens of the State, and also in the interest of the public health, it is the imperative duty of the State to promptly take such action that tuberculosis in cows *shall* be restricted; and that the present very considerable and unnecessary waste of human life because of infected milk shall be stopped.

THE SCALE-INSECTS OR COCCIDÆ.

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The family of scale-insects or Coccidæ forms a natural group, well defined and quite distinct, in many ways, from the rest of the hemiptera with which it belongs. It comprises about 800 species at the present time and new species are constantly being added as they are discovered.

As is usually the case where a natural group is well defined and quite distinct from its allies, the members of the group itself are very much alike and the distinctions between genera and species are very close. When such a state occurs in a family of insects, whose members average in size less than the head of a pin, there is offered opportunity for considerable study.

The family Coccidæ is placed in the Hemiptera Homoptera, usually with the Aleurodidæ and Psyllidæ near the Aphidæ. The fact that three of these families have a common character, that of the beak apparently arising from the sternum, has induced some authors to group the Coccidæ, Aleurodidæ and Psyllidæ together into the super-family Sternorhynchia.

The members of the Coccidæ have a life history that is unique. The metamorphosis is incomplete with the females, and complete with the males, a state of things that does not exist in any other group of insects. The males all have a quiescent pupal stage and emerge as very small, delicate two-winged creatures, whose lives are of such short duration that they require no food and for this reason they have no mouth-parts. In the place where the mouth ordinarily is found, there is placed an extra pair of eyes. The second pair of wings is reduced to a rudimentary condition and each is armed with one or more hooks at the apical end which hooks are placed, during flight, in corresponding folds in the front-wings.

The female does not pass through such a metamorphosis. She is, as an adult, always without wings, and has always a long beak to suck food. The members of some genera are footless sacs, without antennæ or eyes, and capable only of feeding and reproducing. Other genera have females possessing freedom in different degrees. The members of some genera have legs, antennæ and eyes during their entire life. Some are enclosed in sacs of felted material, some secrete a covering of wax,

and some are covered with a waxy or papery shield. The lac insect secretes shellac and lives in cavities in the mass. The female of *Coccus cacti*, the cochineal insect, is free for her entire life and wanders at will over the cactus until she commences to lay her eggs.

There are many insects of economic importance in this family: china-wax is made from one species, shellac and cochineal from two others. The cottony cushion scale nearly destroyed the orange plantations in California before another insect, *Novius cardinalis*, could be imported to destroy the scale. In our own state there are two very serious scales, the San Jose scale and the European Fruit scale, which have been the object of legislation.

The division of the family into sub-families and these into genera is here given for Michigan only. The following list gives the genera now found or likely to be found in Michigan.†

COCCIDÆ.

DIASPINÆ.	
Aspidiotus	*7
Diaspis	*3
Parlatoria	*2
Uhleria	
Mytilaspis	*3
Chionaspis	*7
Ischnaspis	*1
LECANINÆ	
Pulvinaria	*1
Lecanium	*9
HEMICOCCINÆ.	
Kermes	
Asterolecanium	*1
COCCINÆ.	
Dactylopidæ.	
Dactylopius	*5
Pseudococcus	
Ripersia	*1
Orthezia	*1
Acanthococcidæ.	
Ericoccus	*1
Xylococcus	*1
Gossyparia	*1
	44

The asterisks (*) indicate genera already found in the state.

In the Diaspinæ the life-history is substantially as follows: The eggs are hatched usually outside the body of the mother but in some species they are hatched inside, the young issuing alive. The young louse, just from the egg, has antennæ and six legs like an ordinary insect. The two sexes are usually indistinguishable at this stage. The little fellow, so small as to be invisible except when moving, runs about for a few hours and then settles down, inserts its long thread-like beak in the host plant and commences to suck. From this time the position of the insect is fixed. It never moves from the spot first chosen, but in a short time, a few hours ordinarily, commences to secrete the shield or

† This list includes several species commonly imported on fruit.

scale that gives the name to the family. Indeed the legs are shed after the first molt and wandering then becomes impossible. This shield or scale is usually papery, sometimes having a waxy or horny appearance. It entirely covers the insect under it but remains at all times unattached. The two skins that are cast by the female are incorporated with the growing scale, and the first skin shed by the male is likewise utilized. The second skin is shed by the male when the pupal stage is reached and no further growth in the scale takes place after that time, so this skin remains separate and never is incorporated with the scale. Thus we find in the skin of the female, two cast-skins and in that of the male a single one, a feature of great taxonomic value. A short time after the second molt, the male emerges as a delicate winged adult. Mating occurs almost immediately and the male dies.

The eggs are laid by the female under the scale, the body of the female shrinking away to make room for them as they are laid. In some cases, as stated, the young are born alive, the reproduction being ovo-viviparous. The migration of these insects to new places, has to take place just after they emerge from the egg and before the scale-covering is formed. Before the first molt they are provided with legs and these minute lice, so small as to be almost invisible to the unaided eye, in running about to find suitable places for feeding, must crawl onto the bodies of other insects and the feet of birds to be by them carried to new fields of labor. Of course only a small proportion of the lice carried off in this way ever alight on the proper food-plant, and if they do, both sexes must be deposited at the same place or near each other, else they will be unable to reproduce. Happily these conditions help to restrict the spread of these creatures to any great distance except in the case of species that are parthenogenetic. Unfortunately parthenogenesis exists among many species of the Coccidæ and in some species that have been under observation for a long time and which have been repeatedly bred, the male has never been discovered. For instance the males of some species of Lecanium are not yet known though the females have been the object of experimentation for years and has been bred many times. *Orthezia insignis* was not observed to produce males in the United States up to a short time since, but they are occasionally produced in England. I bred the species through three generations and never found a male, though I had the species under observation for the space of three years as well. The effects of two closely allied scales on their respective host plants may be very different indeed. Thus *Aspidiotus ancylus*, a common scale of the orchard and forest, will live a long time on a tree and never seem to cause it any injury or become troublesome, but the European fruit-scale *A. ostreæformis* or the San Jose scale, *A. perniciosus*, will immediately show their effects, causing the tree to die after a few years. Some scales cause a stoppage of growth in the region affected, some discolor the inner bark, staining it a beautiful purple color, some live for years in the same place and do no apparent harm, and some become dangerous only occasionally. It is supposed that the damage is largely due to a fluid injected into the bark for the purpose of increasing the flow of sap to the place infested, just as the poison of a mosquito bite is supposed by some to produce an increased flow of blood to the spot bitten.

The different genera of this large sub-family are separated by the form of the scales and the place occupied by their cast skins. Thus in *Aspidiotus*, the male and female scales are more or less rounded,—the male scale sometimes slightly elongated,—of the same texture, and having as the main difference the possession of two cast skins by the female and only one by the male.

Diaspis has the female scale rounded, with the exuviae more or less central and the male scale white, elongated and more or less carinated.

Chionaspis has the female scale elongate with the cast skins at the cephalic end. The male scale is white, elongated and often carinated.

Mytilispis has the scales of male and female similar in form, both being elongate and seldom either of them white. The cast skins are at one extremity of the scale.

Parlatoria has a female scale rounded or elongate, with the second cast skin usually large and not projecting much beyond the cephalic end of the scale. The male scale is white and not carinated.

Uhleria resembles *Parlatoria* but the female has the second cast skin covered with secretion.

Study of the insect itself under the scale shows that each genus has a distinct type of structure, and after one becomes familiar with the different genera, these structural characters of the insect itself are used to help settle the genus, for the characters given here have some exceptions and the different genera run into one another somewhat.

Specific determination is based largely on the characters of the caudal segment of the female together with the appearance of the scale. An examination of the caudal segment of the female shows a more or less intricate arrangement of plates, spines, and lobes, into a fringe on the hinder border. This arrangement holds pretty constant with each species and while there is variation to a certain degree, usually it is not very great. A study of this fringe requires a compound microscope with at least a one-eighth objective, and for settling some points a one-twelfth is very desirable. Specimens are usually mounted in balsam after boiling in potassic hydrate to clear them.

A discussion of the different species in Michigan would take a long time and will not be attempted at this time, suffice it to mention one or two.

The San Jose scale, *Aspidiotus perniciosus*, was discovered to be in Michigan in 1896 and since that time has been found in a number of localities. It lives on a large number of different plants, including fruit trees, forest trees, shrubs, etc., even working at times on strawberry and grape vine. It spreads very rapidly and affects trees very seriously, ordinarily killing them in a few years if no remedy is applied.

The European Fruit scale, *A. ostreæformis*, was discovered in Michigan about a year ago although it has been here for eight or ten years. It works much as does the San Jose scale but seems to be less dangerous, not killing the hosts outright so often as the San Jose. It is, however, a serious pest and worthy of careful treatment.

The sub-family, *Lecaninæ*, differs in many ways from the *Diaspinæ*. Its members produce no protecting scale and possess no fringe on the caudal segment. There is instead a cleft extending some distance from the caudal margin and two triangular scales at the cephalic end of

this cleft. The members of the sub-family, *Lecaninæ*, possess much more freedom of movement than do those of the sib-family *Diaspinæ*. Many species of the *Lecaninæ* live, as young lice, on the leaves of trees and then migrate to the twigs and limbs to pass the winter, after which they become fixed.

So far as Michigan is concerned, this group has two genera,—*Lecanium* and *Pulvinaria*. Neither secrete a protecting scale, but when a female *Lecanium* is ready to oviposit, she simply dries up into a hard shell on the surface and shrinks away from the eggs, which are left inside this shell, until they hatch and the young crawl out. After this this shell becomes loose from the effects of the weather and in time drops off. To this genus belongs the New York plum scale, *L. cerasifer*, which has proven very serious in certain regions. There are several species in the green houses in Michigan and a good many out of doors.

Pulvinaria resembles *Lecanium* in most particulars but the eggs are laid in a mass of cottony secretion pushed out from under the caudal end of the female.

The next group contains the *Hemicoccinæ*. It is represented in Michigan by two genera, one of them, *Kermes*, has not as yet been recorded but it must be here as the writer has collected it from both sides of Michigan.* *Kermes* is a gall like insect, the segments of the body being solidified into a smooth, even, shiny shell with markings such as are found often on galls. Indeed they have sometimes been mistaken for galls by entomologists and botanists.

Asterolecanium is a smaller form covered with yellow wax. It has been found once in Michigan.

The sub-family Coccinæ contains many diverse forms. We possess six genera in Michigan. The female of *Dactylopius* which genus contains the mealy-bugs, is furnished with antennæ, eyes and six legs throughout her life. She is soft and clearly divided into segments. The body is covered with a mealy secretion, apparently making the entire insect white. *Ripersia* is a good deal like *Dactylopius* but has antennæ of six joints, while the antennæ of *Dactylopius* has antennæ of eight joints.

Orthezia is ornamented with plates of white wax of very beautiful form. There is a long tube of pure white wax at the posterior end which is much larger than the insect itself. It gives her the appearance of being an animated stick of candy. In this tube the eggs are laid and carried about until they hatch into young lice.

Eriococcus is covered with a felted sac in which she lives.

Xylococcus betulæ is a rare insect, found by Messrs. Schwarz and Pergande in northern Michigan. It burrows in the bark of birch trees, ruining the bark for making canoes.

Gossyparia ulmi is the last member of this family found in Michigan. It works on elm trees. The female being able to move about until full-grown when a cushion of cottony material is secreted on which she becomes fixed for the rest of her life.

The object of this paper is to show the members of this section what an interesting group the family Coccidæ is, as well as to give them an idea of what the different species look like. As the writer is working

* Since this paper was written, the writer has collected *Kermes pettiti* on oak, near Agricultural College, Mich.

on a monograph of the Michigan species, any contribution of specimens will be gladly received. I shall be glad to name specimens sent for determination except *Lecaniums*, and shall be glad to get them. A scale may be perfectly familiar to you and still be unrecorded from the state. Its locality is very likely to be new.

We have in Michigan 44 species on record at the present time. Many of these have been found only during the last two or three years, after a special search.

THE DAMAGE DONE TO YOUNG TREES BY DEER AND ELK.

W. J. BEAL, PH. D., AGRICULTURAL COLLEGE.

In the years 1874-75 at the Agricultural College, a small plantation of about one hundred fifty specimens of trees and shrubs was begun covering nearly two acres. In autumn of 1898, I was urged by a member of the faculty to permit him to enclose this arboretum with an area of two acres adjoining, with the view to using it for a "deer park." Although I was certain that nearly all the smaller trees would soon be destroyed if such a plan were adopted, a compromise was made by which a small piece of the arboretum was included in the park. It would be a capital experiment at any rate.

A pair of young elk and a trio of deer were soon placed on the land that had been surrounded by a high wire fence. The work of depredation began promptly and has continued almost daily ever since that time.

Twenty-five or more species of woody plants were exposed to these animals, and without a single exception, all were destroyed or on the direct road to destruction, wherever the tops did not extend above ten feet, and very nearly all were destroyed where the trunk was not over two inches in diameter. A short row of king nut or big shell-bark hickory, *Hicoria*, came as near to exemption from damage as any of the number. The trunks of this species are so tough and the bark so hard that little impression can be made by teeth or horns. Even all the limbs of these hickories, that are within reach to the diameter of an inch or more have been repeatedly twisted and bent by the horns of elk and buck until all life long since disappeared. The leaves and small twigs of the low growth were the first to be attacked.

All vestige of life of such plants did not survive the second summer. Here are the names of some of them: black-cap raspberry, Virginia creeper, honey-suckle, grape vine, blue beech, common locust, black cherry. Two low apple trees with trunks eight inches in diameter were killed the first summer, much of the bark disappearing from the main trunks and nearly all of it from the branches as high as the animals could reach. Swamp white oaks and honey locust with a diameter of two and one-half to three inches were girdled, also chestnuts two and one-half inches through, box elders three inches, white ashes three inches, butternuts and Norway maples three and one-half inches, blue

beeches four inches, sugar maples four and one-half inches, catalpa was broken off and slivered; basswoods were much broken down, but the tough bark seemed to protect the main trunks, though this would avail nothing, because all the leaves and small branches were removed. Some low hawthorns were within the enclosure. So fond were the deer and elk of the leaves and young growth of these bushes, that they cautiously inserted their noses far in toward the middle, using also their feet and horns to aid in the destruction. Later, this low dense hawthorn died.

They are especially fond of the branches of hemlock, white pine, and arbor vitæ, but hesitate a little to devour Norway spruce, although these trees have finally all been destroyed or nearly so.

The food habits of deer and elk are much like those of sheep and goats. They are all fond of a variety and will take a little of this and a little of that, as fancy guides them. Every farmer knows that a flock of sheep is most effective in clearing new fields of sprouts and bushes of every description.

Previous to observing this park, I did not suppose deer or elk destroyed trees and shrubs with their horns, excepting when they were engaged in rubbing the hair and dead skin from their mature antlers, but I have learned that the work continues as long as the horns remain. They rub the trees for exercise, for play, and to work off some of their proclivities for fighting, as they had no males of their species with which to engage in battle.

A week ago, as I went about the fence of the park taking notes, the male elk followed around all the way, as near to me as he could get, showing his power by twisting bushes and rattling the wire fence. He ran down and killed the doe of the flock one day the past winter. Mr. Pettit climbed the fence and was in at the death, but was too late to be of service.

At the time of taking notes, the buck was quiet and harmless, as he had dropped his antlers a few weeks before, but early the year before he took down an old gentleman, who had the curiosity to make a close acquaintance by climbing the fence and entering the park.

This elk appeared vicious, though I kept on one side of the fence and he the other.

In the forests it is not likely that deer or elk ever were sufficiently abundant to make their influence very effective for injury, but if crowded into small areas, like sheep in a pasture, we can readily see what results would follow.

I cannot recommend large herds of deer or elk as valuable accompaniments for a young forest preserve.

A BRIEF HISTORY AND OUTLINE OF THE WORK DONE BY THE BOTANICAL CLUB AT THE MICHIGAN AGRICULTURAL COLLEGE.

GEORGE M. BRADFORD, AGRICULTURAL COLLEGE.

Although the history of the Botanical Club at the college is perhaps familiar to many of those present, yet it may be interesting to note the progress of the club from year to year and recall the work done by former members, many of whom are now well known for what they have accomplished in scientific research.

On September 26, 1890, a mass meeting of students was held in the Agricultural laboratory over which Prof. C. F. Wheeler presided and R. S. Campbell was secretary. Permanent organization of the Botanical Club resulted from this meeting and G. H. Hicks was chosen for the first president and R. S. Campbell secretary. As Dr. Beal some time ago presented a paper to the Academy in which he gave a list of subjects discussed by the club until two years ago, it will not be necessary to go into detail concerning the early work of this organization.

But there are many of the names of workers in this society who deserve honorable mention and whom the Botanical Club is proud to have enrolled among its members. A few years ago they were here as students and now many of them have already performed work in scientific research which reflects credit on their alma mater. Among the former students who have thus distinguished themselves are J. W. Toumey, G. H. Hicks, Lyman J. Briggs, C. B. Smith and H. W. Lawson who have been connected with the United States department of agriculture at Washington. Among those who have been professors or instructors in colleges and high schools are H. J. Hall, A. T. Stevens, W. Paddock, Guy L. Stewart, Leon J. Cole, U. P. Hedrick, D. J. Crosby, D. D. McArthur, F. W. McNair and others. Several soldiers of the Spanish-American war, among them being Capt. Robert Welch, B. Barlow, D. B. Jewell and F. T. Williams, have been members of the club and some of these have contributed to our programs from their experiences in Cuba and Porto Rico.

During the present year it has been the object of the club to discuss subjects not included in the regular course of study here at the college and thus a repetition of the work in the classroom has always been avoided. Meetings are now held on Tuesday evenings of each week in the Botanical Laboratory at 6:30 p. m., lasting usually about an hour. The average attendance is about thirty, although several times this year the number present was as high as sixty and seventy. The present number of active members is forty-four, who take much interest in the work and who are faithful in the preparation of the papers and subjects assigned to them. Several young lady students are members of the club and take an active interest in its proceedings.

The program for each meeting is generally divided as follows: First, There is a talk or lecture of about twenty or thirty minutes in

length given by some one competent to discuss the principal topic of the evening. The second number of the program is usually a short paper or article prepared by some member of the club. This year we have adopted the plan of having biographical sketches of noted botanists presented for this feature of the program. These papers have been found very useful in giving the members not only an idea of the great men who have labored for the advancement of this branch of science, but also a knowledge of the progress made in botanical research during the past one hundred and fifty years. The remainder of the evening is taken up by observations by members present and often this is one of the most valuable and interesting features of the program. The meetings are somewhat informal and questions and discussions on the papers presented are always expected. During the spring term the meeting each alternate week is held in the botanic garden.

An attempt has been made this year to have the subjects discussed in our meetings, either of some economic importance or of such a nature as would interest persons who do not already have an extensive knowledge of botany. We do not aim to discuss deep scientific problems but rather talk about things which will get the average young man or woman interested in botany and encourage him to observe plant life for himself.

Many of the subjects brought before the club this year have been closely connected with important industries related either to agriculture or to the business of the florist. Under this head we have had evenings devoted to the following topics: "The Yeast Plant" by Prof. Marshall; "Dutch Bulbs" by Mr. Gunson; "Types of New Fruits" by Prof. U. P. Hedrick; "Sugar Beets" by Prof. C. D. Smith; "Chicory" by T. G. Phillips. Descriptions of travel and the flora of distant regions have also been important parts of our program. Mr. Barlow has given several interesting talks on the flora of Porto Rico. Prof. Barrows spoke on the plant life of the Argentine Republic, and Prof. Hedrick described the Alpine plants of Oregon and Washington. Considerable attention has been given to parasitic fungi. At different times Mr. Longyear has talked about "Mushrooms and Puffballs" and "The Slime Moulds." Some of the junior class have studied some particular forms of fungi and the "Apple Rust" and "Hollyhock Rust" have been reported on. Among the miscellaneous subjects given were: "The Dispersal of Seeds" by Dr. Beal; "New Michigan Plants" by Prof. Wheeler; "Native Orchids" by Mr. Skeels; "Ferns" by G. M. Bradford. Biographical sketches have been given of Charles Darwin, Linneas, Engelmann, Dr. Watson Torrey, Micheaux, Dr. Vasey, and Amos Eaton. An entire evening was devoted to the life and works of Asa Gray.

Perhaps from this brief outline of the work of the Botanical Club, a few suggestions may be obtained as to how such an organization might be successful in other places, especially in some of the other colleges and high schools in the State. From my own previous experience in other places, I know that it is not difficult to get students interested in such work and it would seem that in this way, there is a large field in creating a popular interest in the natural sciences.

A NEW METHOD FOR THE MECHANICAL ANALYSIS OF SOILS.

J. A. JEFFERY, AGRICULTURAL COLLEGE.

In studying many of the soil problems it is desirable to know the size of the soil grain. Upon the size of the grain depends the amount of moisture the soil will hold capillarily or otherwise, the amount of soluble salts, the rate of solubility of the soil itself, the rate at which the moisture content of the soil will disappear downward by percolation or upward by capillarity and evaporation. Indeed there are few agricultural functions of the soil which do not depend upon the size of the soil grain.

Here is a soil (a) so coarse that the openings between the grains are so large as to be perceptible to the naked eye. Here is one (b) which appears to be so closely arranged as to have no openings or pores, and yet this (a) has but 34 per cent of unoccupied space between its grains, and this (b) has 52 per cent of unoccupied space.

This (a) is a typical truck soil because it allows the passing downward rapidly of the excess of water which may enter it. This in turn allows the rapid warming of the soil, and the ready entry of air, all of which is desirable for the rapid growth and early maturity of vegetables. This soil (b) is a typical grass soil (1) because it does not allow the rapid passing downward of its moisture, and (2) because of the fineness of its grain it presents a very large total surface upon which the roots of the crop may feed, and to hold from loss soluble materials already present.

This soil (b) is so fine that to count the grains contained in a single gram, counting at the rate of one per second ten hours per day, three hundred thirteen days per year, would require five hundred twenty-five years. The grains in a cubic inch of the finest half of this soil, if laid grain touching grain would form three rows reaching from San Francisco to Boston, while the total surface of a cubic foot of this soil amounts to 173,700 square feet or nearly four acres. The average diameter of the soil grain in (b) is estimated to be .004956 mm. or 1-5000 of an inch.

Upon the proportion of fine and coarse grains in its texture depends the classification of a given soil, as to whether it be a sandy soil, a clay soil, a loam, a loamy clay, a clayey loam, and so on.

It becomes evident then that an accurate and ready means of physical analysis is desirable.

For very coarse soils the micrometer with the microscope, or the micrometer calipers may be used, and the average of a large number of measurements taken as the average size of soil grains, or the size of the grains may be determined by counting and weighing, in which case the specific gravity of the soil must be known. But no soils of agricultural value can be measured in this way. For these, three general methods of analysis, or various combinations of these methods, have been employed. In each of these, the soil is separated into groups,

the values of the grains in each group lying within definite known limits or depending upon certain definite conditions.

By one method this separation is accomplished by means of sieves of definite mesh. These sieves differ in size ranging from three mm. to one-tenth mm.

By another method the soil is brought into suspension in water by shaking and stirring, and is afterwards allowed to settle for definite periods ranging all the way from ten seconds to forty-eight hours, and then pouring off the water with all soil still in suspension. In this case the time allowed for settling measures the value of the soil grain in any group. In another form of this method the settling is so timed that with the use of micrometer and microscope the groups obtained in the separation have their grains lying between definite measured limits.

By the third method the separation is accomplished by placing the soil in currents of water of different but definite rates of flow. In this case the rate of flow is the measure of the value of the grains in each group. But with this method also, with some forms of apparatus, it is possible to so regulate the currents that the sizes of grains of each group lie within certain definite limits.

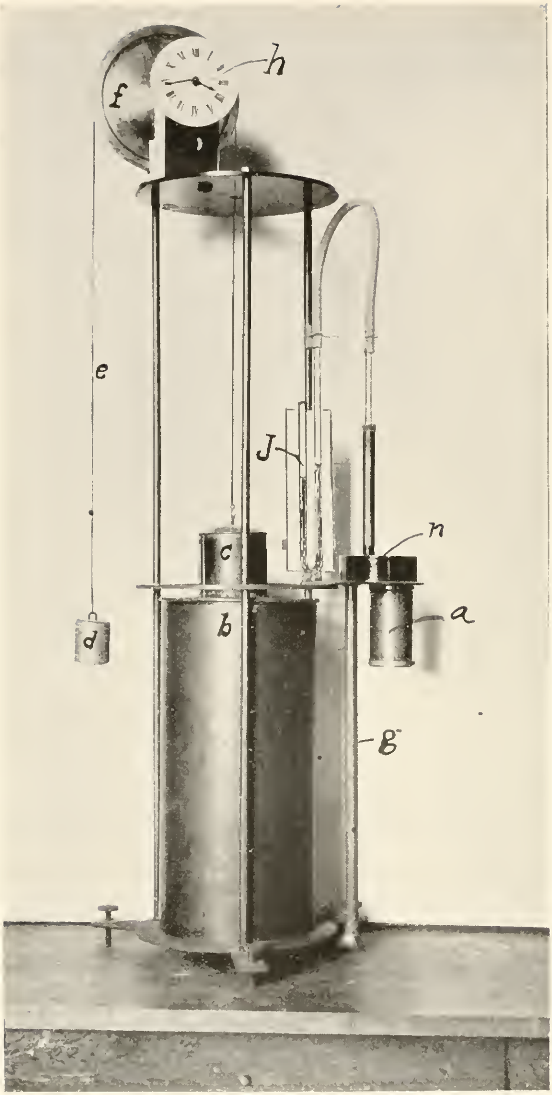
The most satisfactory methods in actual practice combine the use of sieves with one or other of the water methods. By the method most common in this country at this time the grades are made as follows:

1. Gravel, with the size of grain ranging between 2 mm. and 1 mm.
2. Coarse sand with the size of grain ranging between .1 mm. and .5 mm.
3. Medium sand, with the size of grain ranging between .5 mm. and .25 mm.
4. Fine sand, with the size of grain ranging between .25 mm. and .1 mm.
5. Very fine sand, with the grains ranging between .1 mm. and .05 mm.
6. Silt, with the size of grain ranging between .05 mm. and .01 mm.
7. Fine silt, with the size of grain ranging between .01 mm. and .005 mm.
8. Clay, with the size of grain ranging from .005 mm. down to smallest particle.

The first three of these grades are made with sieves, the fourth partly by sieve and partly by gravitation or elutriation; and the last four by gravitation or elutriation.

But there are serious objections to the most satisfactory of these methods. The time required is great at best, days if the clay is separated from the silt. The soil must be prepared by boiling or other equally tedious and often unsatisfactory way. Flocculation of the soil particles must often be guarded against.

The results are not satisfactory in all respects. After the soils are separated into groups, there is no way of determining the average size of soil grains in the groups nor in the total soil. There is, therefore, no way of determining the size of the individual grains nor of estimating the total surface of the soil which is desirable in many of the problems arising in soils. The actual practice is to consider the mean of the extreme limits of any group so separated to be the average size of the



Aspirator for determining the effective size of soil grain.

grains in the group, which is mathematically incorrect, giving an average probably too small.

These and other difficulties led Prof. King, in 1894, to undertake a line of study which resulted in his method for determining what he has been pleased to call the effective size of soil grain.

It had already been asserted that the rate of flow through sand was dependent upon the size of grain. Poiseuille had demonstrated, or it was thought he had, that the flow of liquids and gases through capillary tubes was proportional to the pressure.

It was found, further, that the weight of a given soil that could be packed in a given space was practically constant, and that therefore for a given soil the pore space was constant; and that fairly constant results were to be had in aspirating air through a given soil.

At this time Prof. King conceived the idea that the size of grain of a given soil might be determined in this way. The opinion of Prof. Slichter, Professor of Applied Mathematics at the University of Wisconsin, was asked as to the practicability of the plan, and so thoroughly did he believe in its possibility that he immediately set about developing a formula for making the necessary computation. He was so successful in this that measurements of soil grains have been made with an approach to accuracy that was at first hardly hoped for; and it is hoped that greater accuracy may still be secured as the method is further studied.

The apparatus used is the one before you [see plate], and is essentially the same as the one first used by Prof. King. It differs only in compactness of form. It consists of a soil tube (a), an aspirator of which (b) is the tank, and (c) the bell. The bell is lifted by the weight (d) by means of a cord (e) passing over the pulley (f). The tube (g) passes from the soil tube into the aspirator, and by way of this, air is drawn by the aspirator through the soil in the tube (a). The dial (h) performs the function of air meter, and is calibrated for one litre in this case. The minometer or pressure gauge (j) indicates the difference of pressure between the ends of the soil column in the tube, or conventionally speaking it indicates the pressure under which the air is drawn through the soil. It is connected with the air chamber (n) above (a). The height, cross section, inside volume, and weight of the tube (a) are carefully determined.

Before taking up the mode of operating the apparatus, let us consider briefly the points in Prof. Slichter's theory leading to his formula.

He considers a hypothetical soil having approximately spherical grains of nearly uniform size. The least pore space possible in such a soil occurs when the grains are so arranged that the element of volume is a polyhedron with face angles of sixty or one hundred twenty degrees. In this case each grain of soil is in contact with other grains at twelve points, and the pore space equals twenty-five and ninety-five hundredths per cent. When the grains touch each other at eight points, the element of volume is a cube, and the pore space equals forty-seven and sixty-four hundredths per cent. Between these limits of arrangement we have a similar range of pore space, and the face angle of the element of volume will be a function of the pore space and thus may be determined from it if the angle be known. The angle

in actual practice cannot be known, but conversely the pore space may readily be determined and the angle determined from it.

The length of pore in the soil is greater than the length, or height, of the soil column through which the air is aspirated and depends upon the angle as well as the height of the soil column. The cross section of the pore has for one of its functions the angle as well as the size of the grain, and conversely the size of the grain will depend upon the cross section of the pore. The rate at which air may be aspirated through a soil will depend upon the size and length and number of its pores, upon the pressure under which it is forced through the pores, and upon the viscosity of the air which in turn depends upon the temperature of the air. The length of pore will depend, as before stated, upon the height of the soil column. The number of pores will depend upon the cross section of the soil column, whence we have derived the formula:

$$d^2 = K \frac{h}{spt} \ [8.9431-10]$$

Where d is the diameter of soil grain,

K a factor dependent upon the per cent of pore space,

h height of soil column,

s cross section of soil column,

p pressure in c. m. of water.

t the time in seconds required to aspirate 5 liters of air at 20° centigrade, and [8.9431-10] is the logarithm of a constant.

Such a soil, however, as Prof. Slichter hypothecates is never found and probably seldom approached in nature. It is probably approached more nearly in form than in uniformity of size. But whatever the irregularities in a given soil, it is found, as has been partly stated before, that its minimum pore space and its power to allow the passage of a fluid through its pores are practically constant, and, as Prof. Slichter says: "It would probably be admitted that no matter how complex a soil may be there exists a certain ideal soil of uniform spherical grains that will transmit, under given conditions, the same amount of" fluid (he says water) "that would be transmitted by the complex soil. The size of the grain of this ideal soil of the same transmission capacity as the complex soil we shall call the effective size of grain of the complex soil." This is the term applied to the size of grain as determined by the new method.

THE MODE OF OPERATION.

To perform an analysis the soil is prepared by drying and pulverizing in a mortar, using a rubber pestle. It is then sifted through a 1 mm. mesh sieve to remove gravel.

It is then introduced into the tube (a), the end of which is provided with a tight fitting cap, and the tube held firmly upon some solid surface, and lightly tapped with a light mallet or stick. As the soil settles more soil is added, and this is continued until no further settling occurs. The surplus soil is stricken off, and that which remains is smoothed down with some plane surface. In Prof. King's laboratory a piece of ground glass is used for the purpose. The tube and contents are now weighed. Knowing the volume and weight of the tube, and the specific gravity of the soil, it is an easy matter to determine the pore space

in the soil, and with the pore space determined, K (in the formula) is found by reference to a table.

On the other end of the tube (a) is now screwed a gauze cap, the tube is inverted, the solid cap removed, and the tube is screwed into place. The weight d is next suspended and this acting upon the bell causes the aspiration of the air through the soil. The minometer indicates the pressure under which the air is drawn through the soil. Usually the initial and final pressures are recorded, and the average of the two taken as p in the formula. The pressure should not much exceed three centimeters of water.

The initial and final time are noted and the time required to aspirate one or more liters of air through the soil is determined by subtracting the initial from the final time, and is expressed in seconds. If only one liter is aspirated then the time must be multiplied by five. Substituting these values in the formula, *d* is readily determined.

The question naturally arises how nearly do the determined effective size of soil grain compare with the actual size. Here is a classification of a series of determinations of sizes of sands made both by aspiration and by counting and weighing. This classification is taken from the 19th annual report of the United States Geological Survey, p. 224, with a column added to show the difference.

Number.	Methods of determination. By aspirator.	By count and weight.	Difference.
Series I, water-worn sand:	Mm.	Mm.	Mm.
20	.4745	.4690	.0055
40	.1848	.1745	.0100
60	.1551	.1472	.0079
80	.1143	.1075	.0068
100	.0826	.0759	.0069
Series II, crushed glass, by J. A. Jeffery:			
20	.5028	.5365	—.0337
40	.2845	.3577	—.0732
60	.1868	.2329	—.0461
80	.1380	.1688	—.0308
100	.0797	.1050	—.0291

The sands were building sands, graded by means of soil sieves having 20, 40, 60, 80, 100 meshes to the inch, respectively.

It is seen that with graded sands fairly close results are gotten by the two methods. With the ground glass the marvel is that so nearly close results were obtained, since the particles were anything but spherical in form.

With the finer soils where counting and weighing are impossible we happen to have a check which seems to indicate that the effective size of grain obtained by aspiration is far more nearly the true size of grain than any size determined by any of the old methods.

Having given the size of spheres it is an easy matter to determine their surface.

In an experiment conducted by myself in thesis work, the total surfaces of weighed quantities of samples of clay soil were determined, first using the diameters of grains as determined by the old method,

and second using the diameter of the grains as determined by aspiration. These weighed lots of soil were then subjected to the action of a standard solvent for about ten days, when the losses were determined. Theoretically the losses should be proportional to the total surfaces of the lots of soil. The losses were plotted as were also the surfaces as based upon the diameter determined by the two methods.

There was no apparent relation between the losses and the surfaces obtained by using the diameters obtained by the old method, while the curve of losses was not far from parallel to the curve of surfaces obtained by the aspiration method.

The results obtained by mixing a fine grade of sand with a coarse grade, varying in proportions, do not give results that agree with the theoretical value.

THE LIFE HISTORY OF A VOLCANIC ISLAND.

DR. A. B. LYONS, DETROIT.

The publication recently of an important paper by Prof. C. H. Hitchcock on the Geology of Oahu renders timely a discussion of the general subject of the life history of a volcanic island. Nowhere in the world can this subject be studied to better advantage than in the Hawaiian Islands. Every stage, unless it be the initial one, which necessarily must be unobserved, is here illustrated.

According to ancient Hawaiian tradition, Pele, the goddess of the volcano, dwelt first in the most northerly islands of the group. From time to time she moved her residence southward, occupying in succession Kauai, Oahu, Molokai and Maui, and finally taking up her abode on Hawaii. This is simply a mythological version of the scientific statement that volcanic action in the Hawaiian group has built up the islands in succession beginning at the most northerly, being confined today, as you all know, to the most southerly.

Hawaii, then, represents a volcanic island still in its period of vigorous growth. Mauna Loa, its active volcano, consists of a regular dome, the even curve of its outline as seen in profile almost unbroken by subsidiary cones, its slopes not yet scored in any degree by erosion. The rain which falls copiously on some portions of its slope is absorbed as by a gigantic sponge. Ten or fifteen inches of rain in a day, in the Olaa region is not an uncommon record, yet the word freshet conveys no meaning to the Kamaaina. The water from such a down pour, where it falls on pahoehoe lava will flow down the slope of course, in a broad sheet (there are no water courses for it to follow), but even on pahoehoe it can go but a very short distance before it is sucked into the pores of the vesicular lava. If it falls on aa, it disappears at once.

Mauna Kea, the twin peak, represents the next stage in the life history of a volcano. The cone has been completed, its surface studded with numerous parasitic cones, characteristic of the later stages of volcanic activity. The cone as a whole is steeper than that of Mauna

Loa, the later lava flows having consisted of less fluid material. The prevailing color of the lava is red rather than black. Pahoehoe is rarely if ever met with. Its material, judged by what appears at the surface consists of loose fragments. Of course the deeper structure is the same as in Mauna Loa—made up of successive sheets of lava five to twenty feet or more in thickness, intercalated with the fragmentary material from explosive eruptions, and traversed by dykes representing fissures through which the lava has reached the surface.

Mauna Kea, like Mauna Loa, has its rain belt, the mass of the mountain serving as a condenser for the moisture of the trade winds, but in this case we find the windward slopes of the cone scored deeply in their lower reaches with ravines, carrying to the sea after every rain roaring torrents. The mountain is so high that heavy precipitation extends only about half way to the summit. Accordingly the upper part of the mountain shows as yet only shallow water courses, these being dry except immediately after rain or during a thaw at the mountain summit in winter.

The slope of Mauna Loa is continued in most places quite to the sea level. Where this is not the case, it is not because the sea has encroached on the base of the mountain. This, however, is on the leeward side of the island, where the coast is not subject to violent attack by the waves of the ocean. Mauna Kea, on the other hand, is washed at its base by a sea whose majestic swells roll in with an impetus gained under the incessant lashing of the northeast trade winds over a course of a thousand miles or more. That such an expenditure of energy should produce striking effects might be easily enough predicted, and yet when one sees the base of this new mountain eaten into apparently fully half a mile, the blue ocean dashing against the base of cliffs three or four hundred feet high, one is apt to be a little staggered in the belief that even such a force could be adequate to bring about such a result in so brief a time. We must remember, however, that this action must have begun while the mountain was still an active volcano—must have been in progress, indeed, from the day there was a mountain or an island at all, that it must have been over precipices like these that in ages past the lava floods poured themselves while the mountain was growing most rapidly. It is therefore not true that these escarpments represent the actual removal of a corresponding portion of the mountain's base.

So too the scoring of ravines in the sides of the mountain probably began long before volcanic activity wholly ceased. In one case, indeed, we find the bed of one of the deepest of the ravines occupied with the lava of a recent flow. One would say that this particular lava flow probably occurred less than a thousand years ago, and may be considerably more recent even than that, but it would be safe also to venture the opinion that there have been few if any great lava flows from Mauna Kea within the last ten thousand years.

Hawaii has yet another volcanic cone, so ancient that the precipices on its windward exposure are 1,000 to 1,500 feet high, and yet a "young" mountain, its features still traceable more to the volcanic agencies which formed it than to the shaping of weather and storm. Molokai and West Maui show us volcanoes so changed by erosive agencies that one

must restore them in imagination to recognize their original character, and in islands further north the ruins of the original volcanic structure are so crumbled that their rehabilitation is a task that can be accomplished only by prolonged patient study.

The beginnings of a volcanic island must be generally beyond the reach of scientific observation. Deep beneath the ocean lies the actual vent marking the crest of a fold in the earth's crust. Under stress of a titanic force, into whose origin we do not now seek to inquire, the crust is crumpled and is liable to become fissured where it is folded. A mile perhaps below the surface of the ocean, lava is forced out of such fissure. At this depth no explosion will result from contact of the molten rock with the water. The lava will be chilled very quickly, of course, but it will no doubt absorb a certain amount of water, if it has not already done so in its passage through the fissure, and so will remain fluid at a much lower temperature than it would otherwise. However, at best, the lava must congeal before it can flow to any distance from the vent.

Again and again lava will be emitted at or close to the original vent, building up thus a submarine mountain, much more steep than any subaerial lava cone. In time this is built up to a point where the diminished pressure permits the formation of steam, and now begins a new phase in the volcanic phenomena. The action assumes an explosive character. Repeatedly the top of the cone is blown to fragments and it is a long time before the lava can come to the light of day. By this time there will have been formed a platform of some size on which to build up the new island— a foundation, however, which must consist largely of fragmental matter, piled up at the steepest angle at which it will stand.

The time comes when a sufficient quantity of lava is forced out at once to build up a subaerial crater with a conduit through which the lava may reach the surface without meeting with water enough to produce a disastrous explosion. Often enough even after this explosions do occur and the island may be repeatedly destroyed thereby—the foundation platform made thus broader and more secure.

I need not describe in detail the process by which the island when once established grows, through successive eruptions. I wish, however, to impress the idea of instability in the original foundation, and to call attention to the consequences which must follow from the pouring into the sea of the molten lava. It is evident that this lava will be rapidly chilled and will pile up very close to the shore instead of continuing under water the low-pitch gradient of the cone as it appears above the water. The submarine portion of the island, so far as it is made from lava, must be of a most insecure structure, its material largely fragmental and piled at so steep an angle as to involve great instability. In many cases there will be also quantities of solid matter ejected in explosive eruptions, all fragmental and much of it in a fine state of division. This may be thrown to a considerable distance, and so may enlarge materially the foundation particularly on the leeward side of the island. The base may, indeed, sometimes be buttressed and strengthened by submarine extrusions of lava, which will certainly sometimes find the path of least resistance leading through this loose material.

The island as a product of eruptive activity is at last finished. It is a more or less symmetrical low dome, its slopes extending on the leeward side quite to the sea level, on the windward side terminating abruptly in precipitous cliffs. It is already clothed with forest vegetation on the portions receiving abundant rainfall provided there is other land near by whence seeds may be easily brought. It can hardly fail to have some luxuriant vegetation, if only of ferns. Probably only on the leeward side will there be lava flows on which plant life has not established itself. There may or may not be a summit crater. It is probable that there will be numerous parasitic cones and there may be also near the sea some tufa cones, but these are minor features, all destined to disappear without affecting the final result of the operation of denuding agencies.

What is of much greater consequence is the probability that already the insecurity of the foundation on which the island rests has been manifested in faults that mar the symmetry of the mountain, and which may profoundly affect the result of erosive agencies by giving unexpected direction to their action. It is this possibility which geologists have hitherto failed to take into account. Some most striking illustrations of such faulting exist in the Hawaiian islands, the significance of which came to me a few years ago as a most illuminating revelation.

To me, as to others with whom I had conversed, Waipio valley on the island of Hawaii had been a mystery. A gorge, apparently the work of stream erosion, half a mile wide, with level floor, extends back into the mountain five miles or more, then turns abruptly to the right, pursuing a course parallel with the coast perhaps eight miles, maintaining much of this distance its extraordinary breadth and nearly level floor. On either side the walls rise precipitously 2,000 to 3,000 feet, picturesque waterfalls coursing down at intervals from the mountain above, but occupying only insignificant gullies. From near the point where the valley heads, there starts a counterpart valley, which follows a course at first parallel with the shore line, then abruptly turns seaward, this valley also characterized by precipitous sides throughout its course.

What does it all mean? There can be but one explanation. A section of the mountain, perhaps five miles wide and ten miles long, parallel with the coast has been split away by a fault, dropped down some distance and tilted bodily seaward. To all appearance, another slice external to this has slid off and disappeared completely in the deep sea. This has happened in a region of very abundant rain, and stream erosion has played its subordinate part in carving the valley into its present form. No doubt the excessive rain has had something to do also with causing the catastrophe, not as has been supposed by provoking a volcanic explosion, but by solvent action of the water on the constituents of the rock.

The example does not stand alone. Something very similar must have happened on the island of Molokai, where a somewhat similar valley terminates illogically in a precipice perhaps 400 feet high over which pours the waters of a considerable stream which has not cut for itself a gorge in the cliff. What has taken place you comprehend

when you see that this valley is parallel with a precipice marking a fault by which the whole northern portion of the island has been cut off, to disappear in the deep sea except for a few points that remain as little dots of islands just off the coast. The valley appears to have been formed by a splitting of the mountain by a parallel fault. In this case volcanic agency may have determined the catastrophe, since there has been built at the foot of the precipice a little shelf of land just above sea level consisting of obviously recent lava. But such an eruption may as probably have been a consequence as a cause of the catastrophe.

A still more striking illustration of the faulting I am speaking of is found on the island of Maui, where the immense dome of Haleakala has been split almost through its center, the windward half settling away from the leeward portion so as to submerge the old coast line. Such a fault as this will determine without doubt the whole future history of the mountain, erosive agencies henceforward centering about the two great gorges thus produced on its opposite sides. One recalls immediately the Olowalu pass on West Maui and the Nuuanu gap on Oahu, recognizing at once the analogy in the conditions. It is noticeable in each instance of faulting on this large scale that the catastrophe takes place in a region of abundant rainfall, and also on a coast exposed to the trade wind swell of the Pacific ocean.

Returning to our newly finished island—we might better speak of it as an island on which work has just been begun—possibly it has already suffered from faulting, certainly erosive agencies have begun their work. The task these have undertaken will not be finished as long as a vestige of the mass remains visible. I need say nothing of the general principles which govern the action of these. There are, however, peculiarities in the nature of the mass that is attacked which may materially modify the results of their operation. The first point to note is the heterogeneous character of volcanic accumulations, even in the case of the basalt volcanoes of which I am especially treating. The lava of which such a volcano is built up often appears in section almost like a stratified rock. There is not greater difference in the thickness of the successive beds than in the case of stratified rock of sedimentary origin. The difference, however, in hardness and in resisting power toward disintegrating agencies is often very great. As the fresh lava varies extremely in vesicularity, so, after it has been compacted by pressure and the action of heat, there is no uniformity in its physical character or in its chemical reactions.

Much fragmental material is ejected even from basalt volcanoes, piled up into cinder cones some of which will become buried in the bedded lava to leave material that will be quickly washed out when erosion begins its work. Near Hilo there is a pretty illustration of my point in the natural arch left by the washing out at the base of a promentory of the material of an old buried tufa cone. Observe that fragmental material will be especially abundant in the vicinity of the principal vent, i. e., in the very core of the mountain, so that we must not be surprised to find this part gouged out as it were while the peripheral portions of the cone remain comparatively intact.

The material of laccolites and of dykes may be expected to have much higher resisting powers than the ordinary lava. The name dyke, indeed,

comes from this peculiarity. On the other hand such material is much more likely to have a regularly jointed or columnar structure which may render it liable to be quickly washed out by wave or stream erosion. The Rainbow Fall near Hilo owes its existence to the columnar structure of the basalt, and it is only one instance of many. Fingal's cave is a conspicuous illustration of the havoc the ocean makes with such material.

Again, volcanic cones are necessarily penetrated by vertical fissures through which water readily penetrates to great depths. If the water filters through such pores and crevices as it ordinarily finds in sedimentary rocks, it loses its dissolved oxygen and carbonic acid before sinking many inches into the rock. It is otherwise if it finds free passages, and so its power to do chemical work at considerable depths is greatly increased. The ducts which remain open in the center of a great lava flow—galleries, frequently six to ten feet in diameter and extending continuously it may be several hundred yards, serve also as subterranean conduits, and not unfrequently they determine the position of streamlets destined to cut deep ravines.

Volcanic rocks differ from most sedimentary and metamorphic rocks (calcareous of course excepted) in the completeness of their destruction by weathering. The sand used for building in the Hawaiian islands is all brought from abroad. There is sand of course on the sea shore at home, but it consists commonly of fragments of sea shells and corals. In some places you will find black sand, but on examination it will almost always prove to be simply fragments of the lava rock having no enduring quality like the grains of an ordinary quartz sand. More rarely you will meet with a sand composed of grains of chrysolite or of magnetite, the most enduring minerals that occur in the lava, but even these are chemically short-lived. The ultimate resultant, then, from the disintegration of lava is not sand grains but impalpable dust, so that our island cannot be expected to leave behind even a sand bank to mark its site when the elements shall have done their work of destruction upon it.

As illustrating this destructibility of the volcanic material, I call to mind an interesting formation I once found at tide level on Oahu, a conglomerate consisting of beach worn lava pebbles cemented together with calcium carbonate. The pebbles obviously represented the hardest and most enduring portion of the country rock, yet I found them eaten out from the cementing material which was one we customarily regard as particularly destructible. What was most interesting in this case was the fact that most of the pebbles had been eaten out in the interior leaving a shell of more resistant material, this quality of resistance apparently the result of the compacting of the shell by the pounding of the pebbles on the beach.

The lava when fresh is a sufficiently tough material. The geologist's hammer often suffers in controversy with some of the compact varieties of basalt, so long as these are sound—I was about to write new, but I call to mind some very refractory boulders I have tried to sample that came from eruptions that occurred certainly a thousand centuries ago. I have seen rocks no older, and probably originally quite as hard, which you might crumble to powder between your fingers. The first had never

been exposed long to the action of water, the latter had long ago forgotten what it was to be dry. Moisture, then, is the all important factor in denudation where volcanic rocks are concerned.

Our hypothetical island stands in the path of the trade wind which condenses its moisture into clouds that hang perpetually about its summit or on its flanks, maintaining an altitude between 1,500 and 5,000 feet, keeping the rocks almost perpetually in a damp condition and drenching them at frequent intervals with tropical showers. One consequence is a luxuriant vegetation which flourishes in spite of the fact that the rain washes away soil as fast as it is formed.

At first, indeed, the vesicular lava sucks in the rain like a sponge, but it is not long before incipient decomposition of the rock supplies clay for puddling the surface and soon, geologically speaking, streamlets will begin to seek out the lines of least resistance on the surface and will then set themselves to remove the obstacles they find in their path. So stream erosion is begun. It proceeds slowly at first, for it has to act on a very tough material, but that which mechanical violence fails to accomplish, the magic of chemical affinity effects, and as soon as any channel at all is formed, this quasi solvent action of water is localized exactly where it will be most effective, in the rocks immediately underlying the bed of the stream.

Meanwhile vegetation is playing its important part, mosses and ferns wrapping the rocks to keep them wet, the roots of shrubs and trees penetrating every crevice with their powerful wedges, vegetable acids and products of vegetable decay making havoc of the molecular structure of the rock. All this is a very familiar story to you, no doubt. So too is the process next to follow, of scoring the slopes of the cone with ravines radiating from the center—begun at the base where the volume of water is greatest, passing through the various phases which result in the complex of knife-edge ridges separating deep and steep-walled valleys that characterizes the later stages in the life history of a mountain. That this succession of changes will proceed with extraordinary rapidity in material such as I have described, if conditions are favorable, it is almost superfluous to say. There are however a few points in connection with the progress of this denudation that are especially worthy of remark. Since the chemical effects associated with the presence of moisture are of vastly greater consequence than the mechanical action of the water, the valleys formed will retain in their lower stretches the character of canyons, narrow with precipitous sides and insignificant lateral valleys. The upper portion will assume the V-shape, with numerous V-shaped tributary valleys, or in the later period will take the amphitheater form. The portions of the lower slopes included between the canyons will therefore finally remain as isolated peaks—outliers—connected only by vestiges of the original ridges with the central mass. With this rationale in mind it is generally not difficult to reconstruct in imagination from the remaining fragments, even when these constitute an insignificant part of the whole, the original mountain.

The elevation of the mountain, especially in a region where the trade wind prevails, will have much to do with the dissecting of its mass by rain. If the mountain is more than about 7,000 feet high the clouds

which form on the windward side will deposit rain only on that side, the leeward side not only receiving no rain but remaining generally free from cloud. Under these conditions the valleys on the leeward flank of the mountain will retain their canyon form even in their upper portions. If, as in the Hawaiian islands, occasional heavy rains occur near sea level on the leeward as well as the windward side of an island, the valleys may be broadened somewhat in the lower part, but these copious occasional rains have little effect after all in disintegrating the lava, which in the intervals lies exposed to a cloudless sun in a region bare of shrubbery.

If the mountain is less than 5,000 feet high, clouds will lie much of the time over the whole summit and a portion of the rain will fall on the leeward side of the mountain. If the elevation is barely 3,000 feet much the greater part of the rain will be discharged on the leeward side. There will be in each case a point of maximum rainfall, and here we shall find evidence of greatest activity in the work of erosion.

The island of Hawaii illustrates how even in the case of very lofty mountains, there may be an area of excessive precipitation on what would seem to be the sheltered portion of the island. There is here possibly a key to the apparent anomaly of the extraordinary weathering of the leeward side of the Kaala mountain mass on Oahu, but of this more hereafter.

The last stage in the life history of a volcanic island will be naturally a prolonged and uneventful one. Denudation has proceeded so far that little or no condensation of moisture is occasioned by the insignificant remaining ridges, which therefore weather very slowly, crumbling, however, little by little to dust, and carried finally by wind and rain back to the ocean from which it emerged.

I have recited with some fullness of detail this story of the normal life history of a volcano because it is only by a familiar acquaintance therewith that it is possible to read backward the same history from any stage except the very latest in a study of the ruins that remain. The data for such a study will not, however, be complete if we ignore the possibility that there may have been important changes in sea level, and often coincidently in climatic conditions, due to geological events in other parts of the world. The evidences of such changes will be easily enough found if we are alert to look for them.

Again there is the possibility—almost the certainty—that there will be repeated recurrence of volcanic action, which will build anew amid the ruins of the old structure but with no reference to its original plan.

The problems presented by the island of Oahu are peculiarly complicated in that the present island has been formed by the fusion of two volcanoes, one notably older than the other, and further because of the repeated and numerous volcanic outbreaks, not confined, as usual, to the peripheral portion of the island.

The paper of Prof. Hitchcock seeks to arrange in their chronological sequence the principal events in this very interesting history. Confessedly it leaves much for future students to verify and fill out. It presents a skeleton outline of what science has definitely established, giving in most cases convincing reasons for the conclusions drawn.

The importance to future investigators of such a succinct and comprehensive statement of conclusions is manifest.

The actual geological history of the island of Oahu is to be reached by reading backward, as I have already said, the general story I have outlined, starting with the concluding chapter as its record is presented in the existing features of the island. The fringe of coral reef rock just above sea level all around the coast constitutes that last chapter, telling of a recent emergence of the land as a whole from the sea. Restore the old sea level and we shall see the island as it was in the immediately preceding stage, its land area materially less than at present.

The present surface of the island is encumbered with material discharged from recent volcanic vents, all this we must clear away in imagination. The scenery about Honolulu will be robbed thus of its most striking and distinctive features. The Tantalus group of sand hills must go first, laying bare once more sharp ridges corresponding with those on either side. The convenient grading up of Nuuanu valley from the city to the "pali" is an innovation not to be tolerated, we must restore the old valley bed, much more contracted than at present, and growing steeper as it is ascended according to rule. Picturesque Diamond Head may remain for a while, but it must go before long, with Punchbowl and Koko Head and the rest of the tufa cones of the peripheral region, and so must Rocky Hill and Kaimuki. I am not now indicating the precise order in which they must be banished but insisting simply that they must go from our mental picture.

Next we must restore flesh to the bones of our skeleton island, adding material at every point where we find erosion particularly active, exactly reversing thus the process by which the land has been shaped. The valleys on the leeward side must thus be filled first, the mountain tops raised until they form a barrier to keep back the rain, and then the work of rapid reconstruction must be transferred to the windward side. We must lift our island as a whole once more out of the water, restoring a condition which shall permit the growth of corals on its fringe where today the ocean stands at a level a thousand feet higher.

We must picture the Koolau mountain when it was almost a counterpart of what we see today on Molokai, its leeward side almost intact, its windward exposure eaten into by stupendous ampitheaters of erosion, and then we must call up from the depths of ocean the great slices of the old island that have parted from the mountain mass by faulting. We shall have a vision at last of a volcanic dome not less than 6,000 feet high, sloping gradually to the shore line on the south, resting against the Kaala mountain on the west and ending on the northeast in an escarpment of cliff somewhere beyond Mokapu point.

All this time we shall have seen only a slow progress in the restoration of the Kaala mountain, sheltered as it is from the trade wind by the Koolau mountain. But now we have to watch a reversal of the process by which this latter was built up. Once more we see the mountain blazing at intervals with the volcanic fires which have heaped up over its great dome hills of scoria and marked its surface with the blackened and desolated track of lava streams. The great eruptions which occasionally pour into the ocean rivers of molten rock now

MANLY MILES.

From a photograph taken in December, 1891.

occasion on the neighboring mountain deluging rains from condensation of the steam thus produced. It is probable that the Waianae region is a center of electrical disturbance in connection with these eruptions, and that under the torrential rains accompanying them the mountain wastes like a snowbank in a March thaw.

So as our vision extends backward through the centuries, while the dome of the Koolau mountain grows ever lower, Kaala is filling up its outlines, gaining in altitude and slowly assuming in its turn the features of a recent volcano. The mountains are now separated by a channel of ocean, which widens and deepens as the Koolau mountain becomes swallowed up again in the deep sea, and Kaala stands as an island by itself, perhaps by this time an active volcano, and we have only to follow back the thread of the history step by step through a few more millenniums of time to see, where Oahu is now marked on our maps, only an unbroken expanse of blue ocean.

SKETCH OF MANLY MILES.*

To Dr. Manly Miles belongs the distinction of having been the first professor of practical agriculture in the United States, as he was appointed to that then newly instituted position in the Michigan Agricultural College in 1865.

Professor Miles was born in Homer, Cortland county, New York, July 20, 1826, the grandson of Manly Miles, a soldier of the Revolution; while his mother, Mary Cushman, was a lineal descendant of Miles Standish and Thomas Cushman, whose father, Joshua Cushman, joining the Mayflower colony at Plymouth, Massachusetts, in 1621, left him there with Governor Bradford when he returned to England.

When Manly, the son, was eleven years old, the family removed to Flint, Michigan, where he employed his time in farm work and the acquisition of knowledge, and later in teaching. He had a common school education, and improved all the time he could spare from his regular occupations in reading and study. It is recorded of him in those days that he was always successful in whatever he undertook. In illustration of the skill and thoroughness with which he performed his tasks, his sister relates an incident of his sowing plaster for the first time, when his father expressed pleasure at his having distributed the lime so evenly and so well. It appears that he did not spare himself in doing the work, for so completely was he covered that he is said to have looked like a plaster cast, "with only his bright eyes shining through." A threshing machine was brought on to the farm, and Manly and his brother went round threshing for the neighbors. Industrious in study as well as in work, the boy never neglected his more prosaic duties to gratify his thirst for knowledge. He studied geometry while following the plow, drawing the problems on a shingle,

* Dr. Manly Miles was a charter member of the Michigan Academy of Science. The present sketch is reprinted, with some minor corrections, from the Popular Science Monthly, April, 1899. W. B. B.

which he tacked to the plow-beam. Whenever he was missed and inquiry was made about him, the answer invariably was, "Somewhere with a book." He was most interested in the natural sciences, particularly in chemistry and its applications to agriculture, and in comparative physiology and anatomy, and was a diligent student and collector of mollusks.

Choosing the profession of medicine, Mr. Miles was graduated M. D. from Rush Medical college, Chicago, in 1850, and practiced till 1859. In the meantime he became greatly interested in the subject of a geological survey of the State, for which an act was passed and approved in 1858. In the organization of the survey, in 1859, he was appointed Assistant State Geologist in the department of zoölogy; and in the next year was appointed professor of zoölogy and animal physiology in the State Agricultural college at Lansing.

In his work as zoölogist to the State Geological Survey, in 1859, 1860, and 1861, he displayed rare qualities as a naturalist, so that Mr. Walter B. Barrows, in recording his death in the bulletin of the Michigan Ornithological Club, expresses regret that many of the years he afterward devoted to the development of experimental agriculture "were not spent in unraveling some of the important biological problems which the State afforded, which his skill and perseverance would surely have solved." He was a "born collector," Mr. Barrows adds, "as the phrase is, and his keen eyes, tireless industry, and mathematical precision led to the accumulation of thousands of valuable specimens and more valuable observations."

Mr. Bryant Walker, of Detroit, who knew Professor Miles well in later years, and had opportunity to review his zoölogical work, regards the part he took during this service in developing the knowledge of the fauna of the State as having been very prominent. "The catalogues he published in the report for 1860 have been the basis for all work since that time." He kept in correspondence with the most eminent American naturalists of the period, including Cope, Prime, Lea, W. G. Binney, Baird, and Agassiz, and supplied them with large quantities of valuable material. From the many letters written by these naturalists which are in the possession of his friends, we take, as illustrating the character of the service he rendered and of the trust they reposed in him, even previous to his going on the survey, one from Agassiz, of February 4, 1856:

"Dear Sir: As you have already furnished me with invaluable materials for the natural history of the fishes of your State, I am emboldened to ask another favor of you. I am preparing a map of the Geographical distribution of the Turtles of North America, and would be greatly indebted to you for any information respecting the range of those found in your State, as far as you have noticed them, even if you should know them only by their common names, my object being simply to ascertain how far they extend over different parts of the country. If you could add specimens of them, to identify them with precision, it would be, of course, so much the better; but as I am almost ready for the press, I could not for this paper await the return of spring, but would thank you for what you could furnish me now. I am particularly interested in ascertaining how far north the different species

inhabiting this continent extend." On the back of this letter was Dr. Miles's endorsement that a box had been sent.

A number of letters from Professor Baird, of 1860 and 1861, relate to the identification of specimens collected by Dr. Miles, and to the fishes of Michigan, and contain inquiries about gulls and eggs. Dr. Miles likewise supplied Cope with a considerable amount of material concerning Michigan reptiles and fishes.

While mollusks were the favorite object of Dr. Miles's investigations, he also made studies and valuable collections of birds, mammals, reptiles, and fishes; and he seems, Mr. Barrows says, "to have possessed, in a high degree, that strong characteristic of a true naturalist, a full appreciation of the value of good specimens. Many of his specimens are now preserved at the Agricultural college, and among his shells are many which are of more than ordinary value from having served as types of new species, or as specimens from type localities, or as part or all of the material which has helped to clear up mistakes and misconceptions about species and their distribution." Mr. Walker speaks of his having done a great work in conchology. His catalogue, which contained a list of one hundred and sixty-one species, was by far the most complete published up to that time. "He described two new species —*Planorbis truncatus* and *Unio leprosus*. The former is one of the few species which are, so far as known, peculiar to Michigan, and is a very beautiful and distinct form; while the latter, although now considered as synonymous with another species, has peculiarities which in the then slight knowledge of the variability of the species was a justification of his position. He was also the discoverer of two other forms which were named after him by one of our most eminent conchologists—viz., *Campeloma Milesii* (Lea) and *Goniobasis Milesii* (Lea)." Mr. Walker believes that "in general, it can be truthfully stated that Dr. Miles did more to develop the general natural history of the State (Michigan) than any other man either before or since he completed his work as State Zoölogist."

As professor of zoölogy and animal physiology, Dr. Miles is described by one of his students, who afterward became a professor in the college and then its president, as having been thoroughly interested in the subjects he taught, and shown that interest in his work and in his treatment of his students. He labored as faithfully and industriously with the class of five to which President Clute belonged as if it "had numbered as many score." He supplemented the meager equipment of his department from his more extensive private apparatus and collections, which were freely used for class work; and, when there was need, he had the skill to prepare new pieces of apparatus. "He was on the alert for every chance for illustration which occasion offered: an animal slaughtered for the tables gave him an opportunity to lecture on its viscera; a walk over the drift-covered fields found many specimens of rock which he taught us to distinguish; the mud and the sand banks along the river showed how in the periods of the dim past were formed fossil footprints and ripples; the woods and swamps and lakes gave many useful living specimens, some of which became the material for the improvised dissecting room; the crayon in his hand produced on board or paper the chart of geologic ages, the table of classification, or the drawing of the part of an animal under discussion."

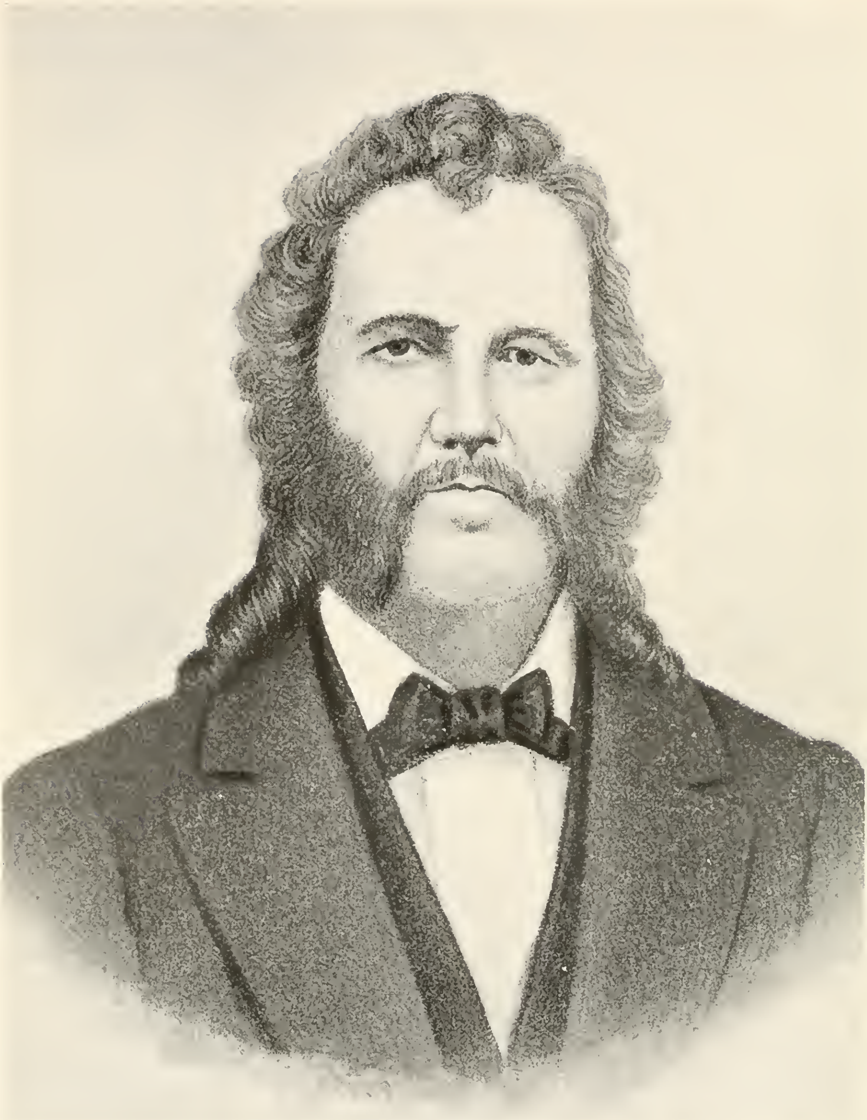
Prof. R. C. Kedzie came to the college a little later, in 1863, when Dr. Miles had been for two years a professor, and found him then the authority "for professors and students alike on beasts, birds, and reptiles, on the stones of the field, and insects of the air," thorough, scholarly, and enthusiastic, and therefore very popular with his classes.

The projection of agricultural colleges under the agricultural college land grant act of 1862 stimulated a demand for teachers of scientific agriculture, and it was found that they were rare. Of old school students of science there was no lack—able men, as President Clute well says, who were familiar with their little laboratories and with the old theories and methods, but who did not possess the new vision of evolution and the conservation of energy, men of the study rather than the field, and least of all men of the orchard and stock farm; and they knew nothing of the practical application of chemistry to fertilization and the raising of crops and the composition of feed stuffs, of physiology to stock-breeding, and of geology and physics to the study of the soils.

With a thorough knowledge of science and familiarity with practical agriculture Professor Miles had an inclination to enter this field, and this inclination was encouraged by President Abbott and some of the members of the Board of Agriculture. He had filled the professorship of zoölogy and animal physiology with complete success, and had he consulted his most cherished tastes alone he would have remained there, but he gradually suffered himself to be called to another field. The duties of "acting superintendent of the farm" were attached to his chair in 1864. In 1865 he became professor of animal physiology and practical agriculture and superintendent of the farm; in 1869 he ceased to teach physiology, and gave his whole time to the agricultural branch of his work; and in 1875 the work of the superintendent of the farm was consigned to other hands, and he confined himself to the professorship proper of practical agriculture.

The farm and its appurtenances, with fields cumbered with stumps and undrained, with inadequate and poorly constructed buildings, with inferior live stock, and everything primitive, were in poor condition for the teaching or the successful practice of agriculture. Professor Miles' first business was to set these things in order. Year by year something was done to remove evils or improve existing features in some of the departments of the life and management of the premises, till the concern in a certain measure approached the superintendent's ideal—as being a laboratory for teaching agriculture, conducting experiments, and training men, rather than a money making establishment.

In this new field, Professor Kedzie says, Professor Miles was even more popular than before with the students, and created an enthusiasm for operations and labors of the farm which had been regarded before as a disagreeable drudgery. The students "were never happier than when detailed for a day's work with Dr. Miles in laying out some difficult ditch or surveying some field. One reason why he was so popular was that he was not afraid of soiling his hands. His favorite uniform for field work was a pair of brown overalls. The late Judge Tenney came to a gang of students at work on a troublesome ditch and inquired where he could find Dr. Miles. 'That man in overalls down in the quicksands of the ditch is Dr. Miles'; the professor of practical agriculture was in touch with the soil."



DENNIS COOLEY, M. D.

DANIEL CLARK, M. D.

Prof. Byron D. Halsted, of the New Jersey Agricultural College Experiment Station, who was an agricultural pupil of Dr. Miles in Lansing, characterizes him as having been a full man who knew his subjects deeply and fondly. "In those days I am safe in writing that he represented the forefront of advanced agriculture in America. He was in close touch with such men as Lawes and Gilbert, Rothamstead, England, the famous field-crop experimenters of the world, and as for his knowledge of breeds of live stock and their origin, Miles' Stock-Breeding is a classic work. Dr. Miles, in short, was a close student, a born investigator, hating an error, but using it as a stepping stone toward truth. He did American farming a lasting service, and his deeds live after him."

While loved by his students, most of whom have been successful and many have gained eminence as agricultural professors or workers in experiment stations, and while receiving sympathy and support from President Abbott, Dr. Miles was not appreciated by the politicians, or by all of the Board of Agriculture, or even by the public at large. Unkind and captious criticisms were made of his work, and it was found fault with on economical grounds, as if its prime purpose had been to make money. He therefore resigned his position in 1875, and accepted the professorship of agriculture in the Illinois State University. Thence he removed to the Houghton Farm of Lawson Valentine, near Mountainville, N. Y., where he occupied himself with scientific experimental investigation. He was afterward professor of agriculture in the Massachusetts Agricultural College, at Amherst. In announcing this appointment to the students, Dr. Chadbourne, then president of the institution, and himself a most successful teacher, stated that he considered Dr. Miles as the ablest man in the United States for that position. In 1886, shortly after Dr. Chadbourne's death, Dr. Miles returned to his old home in Lansing, Michigan, where he spent the rest of his life in study, research, and the writing of books and articles for scientific publications.

During these later years of his life he took up again with what had been his favorite pursuit in earlier days, but with which he had not occupied himself for thirty years—the study of mollusks—with the enthusiasm of a young man, Mr. Walker says, who being interested in the same study, was in constant correspondence with him at this time; "and as far as his strength permitted labored with all the acumen and attention to details which were so characteristic of him. I was particularly struck with his familiarity with the present drift of scientific investigation and thought, and his thorough appreciation of modern methods of work. He was greatly interested in the work I was carrying on with reference to the geographical distribution of the mollusca, and, as would naturally be supposed from his own work in heredity in connection with our domestic animals, took great pleasure in discussing the relations of the species as they are now found and their possible lines of descent. He was a careful and accurate observer of nature, and if he had not drifted into other lines of work would undoubtedly have made his mark as a great naturalist. As it is, his name will always have an honored place in the scientific history of Michigan."

When Professor Miles began to teach in the Michigan Agricultural College, the "new education" was new indeed, and the text-book method still held sway. But the improved methods were gradually taking the place of the old ones, and Professor Miles was one of the first to co-operate in them, and he did it with effect. He used text-books, "but his living word," President Clute says, "supplemented the book; and the animal from the farm under his knife and ours, the shells which he led us to find under rotten logs and along the rivers and lakes, the insects he taught us to collect and classify, the minerals and fossils he had collected on the geological survey of Michigan, all were used to instruct and inspire his students, to cultivate in them the scientific spirit and method."

Among the more important books by Professor Miles are Stock-Breeding, which had a wide circulation and has been much used as a class-book; Experiments with Indian Corn, giving the results of some important work which he did at Houghton Farm; Silos and Ensilage, which helped much in diffusing knowledge of the silo in the times when it had to fight for recognition; and Land Drainage. Of his papers, he published in the Popular Science Monthly articles on Scientific Farming at Rothamstead; Ensilage and Fermentation; Lines of Progress in Agriculture; Progress in Agricultural Science; and How Plants and Animals Grow. To the American Association for the Advancement of Science he contributed papers on Energy as a Factor in Rural Economy; Heredity of Acquired Characters (also to the American Naturalist); Surface Tension of Water and Evaporation; Energy as a Factor in Nutrition; and Limits of Biological Experiments (also to the American Naturalist). Other articles in the American Naturalist were on Animal Mechanics and the Relative Efficiency of Animals as Machines. In the Proceedings of the American Educational Association is an address by him on Instruction in Manual Arts in Connection with Scientific Studies. The records of the U and I Club, of Lansing, of which he was a valued member for ten years, contain papers on a variety of scientific subjects which were read before it, and were highly appreciated. This list does not contain all of Professor Miles' contributions to the literature of science, for throughout his life he was a frequent contributor to the agricultural and scientific press, and a frequent speaker before associations and institutes, "where his lectures were able and practical."

No special record is made of the work of Professor Miles in the American Agriculturist, but the correspondence of Professor Thurber with him furnishes ample proof that he was one of the most trusted advisers in the editorial conduct of that journal. The familiar tone of Professor Thurber's letters, and the undoubting assurance with which he asked for information and aid on various subjects, well demonstrate how well the editor knew whom he could rely upon in an emergency.

In all his work the great desire of Professor Miles was to find and present the truth. His merits were recognized by many scientific societies. He was made a corresponding member of the Buffalo Society of Natural Sciences in 1862; a corresponding member of the Entomological Society of Philadelphia in January, 1863; a correspondent of

the Academy of Natural Sciences of Philadelphia in 1864; a member of the American Association for the Advancement of Science in 1880, and a Fellow of the same body in 1890; and held memberships or other relations with other societies; and he received the degree of D. V. S. from Columbia Veterinary College, New York, in March, 1880.

His students and friends speak in terms of high admiration of the genial qualities of Professor Miles as a companion. The resolutions of the U and I Club of Lansing describe him as an easy and graceful talker, a cheerful dispenser of his learning to others. "To spend an hour in his 'den,' and watch his delicate experiments with 'films,'" says President Clute, "and see the light in his eyes as he talked of them, was a delight." "He was particularly fond of boys," says another, "and never seemed happier than when in the company of boys or young men who were trying to study and to inform themselves, and if he could in any way assist them he was only too glad to do so;" and he liked pets and children. Incidents are related showing that he had a wonderful accuracy in noting and recollecting the minutest details that came under his observation—a power that he was able to bring to bear instantly when its exercise was called for.

Dr. Miles kept up his habits of reading and study to the last days of his life; but all public work was made difficult to him in later years by an increasing deafness. He was tireless in investigation, patient, and always cheerful and looking for the bright side; and when one inquired of him concerning his health, his usual answer was that he was "all right," or, if he could not say that, that he would be "all right tomorrow."

No sketch of Dr. Miles is complete without a word of tribute to his high personal character, his life pure and noble in every relationship, his unswerving devotion to truth, and the unfaltering loyalty to his friends, which make his memory a benediction and an inspiration to all who knew him well.

He was married in 1851 to Miss Mary E. Dodge, who remained his devoted companion until his death, which occurred February 15, 1898.

SKETCH OF DR. DENNIS COOLEY.

W. J. BEAL, PH. D.

Dr. Dennis Cooley was born at Deerfield, Massachusetts, February 18, 1787; graduated at the Medical College of Berkshire in 1822; practiced medicine for five years in Georgia; moved to Macomb county July, 1827, locating in Washington township, where he resumed practice until 1856. He was a great lover of science, especially of botany, and for many years devoted much time to the study of the flora of his adopted county, accumulating a large and valuable herbarium of about 4,000 plants, which are now the property of the Agricultural College, where they are well mounted and well preserved.

Dr. Cooley married Elizabeth Anderson, of Deerfield, Massachusetts, by whom there were two daughters, both of whom died while young. In 1836, he married Clara Andrus, of Macomb county. He was of Scotch descent and a member of the Methodist church. He was appointed postmaster in July, 1836, and held the position continuously for 23 years. He died September 8, 1860.

SKETCH OF DANIEL CLARKE.

W. J. BEAL, PH. D.

Dr. Daniel Clarke was born in Danvers, Massachusetts, in 1812; graduated from Harvard University in the departments of arts and sciences and medicine, taking his degree of M. D. in 1835. In 1840, he came to Flint, Michigan, where he resided continuously until his death in 1884.

He was for most of his life an enthusiastic student of natural history, and was especially interested in botany, accumulating an herbarium of over 5,000 plants which finally came into possession of the State Agricultural College. He was one of the founders of the Flint Scientific Institute which won considerable renown in its day.

He took a very active part in the educational work of his city, where he was a member of the school board continuously for over a quarter of a century. The fine library of the Flint High School was well started through his personal efforts.

He was physician for the State School for the Deaf from the time of its organization until compelled to resign by reason of advancing age.

He was an authority on horticultural matters and his advice was frequently sought by fruit-growers in the vicinity of his home.

He was a modest and unassuming man, thoroughly unselfish, winning the respect and love of his fellow citizens. Always ready to give enthusiastic support to any enterprise which looked to the moral or educational interests of his city or State.

CONSTITUTION

OF THE

MICHIGAN ACADEMY OF SCIENCE.

ARTICLE I.

This Society shall be known as The Michigan Academy of Science.

ARTICLE II: Objects.

The objects of this Academy shall be scientific research and the diffusion of knowledge concerning the various departments of science.

ARTICLE III: Membership.

The Academy shall be composed of *Resident Members, Corresponding Members, Honorary Members, and Patrons.*

1. Resident Members shall be persons who are interested in scientific work and resident in the State of Michigan.

2. Corresponding Members shall be persons interested in science, and not resident in the State of Michigan.

3. Honorary Members shall be persons distinguished for their attainments in science, and not resident in the State of Michigan, and shall not exceed twenty-five in number.

4. Patrons shall be persons who have bestowed important favors upon the Academy, as defined in Chapter I, Paragraph 4 of the By-Laws.

5 Resident Members alone shall be entitled to vote and hold office in the Academy.

ARTICLE IV: Officers.

1. The officers of the Academy shall consist of a President, a Vice-President of each Section that may be organized, a Secretary, and a Treasurer.

These officers and all past presidents, shall constitute an Executive Committee, which shall be called the *Council.*

2. The President shall discharge the usual duties of a presiding officer at all meetings of the Academy, and of the Council. He shall take cognizance of the acts of the Academy and of its officers, and cause the provisions of the Constitution and By-Laws to be faithfully carried

into effect. He shall also give an address to the Academy at the closing meeting of the year for which he is elected.

3. The duties of the President in case of his absence or disability shall be assumed by one of the Vice-Presidents who shall be designated by the Council.

The Vice-Presidents shall be chairmen of their respective Sections. They shall encourage and direct research in the special branches of science included within the Sections over which they preside.

4. The Secretary shall keep the records of the proceedings of the Academy, and a complete list of the members, with the dates of their election and disconnection with the Academy. He shall also be the Secretary of the Council.

The Secretary shall co-operate with the President in attending to the ordinary affairs of the Society. He shall attend to the preparation, printing and mailing of circulars, blanks, and notifications of elections and meetings. He shall superintend other printing ordered by the Academy, or by the President, and shall have charge of its distribution under the direction of the Council.

The Secretary, unless other provision be made, shall also act as *Editor* of the publications of the Academy and as *Librarian* and *Custodian* of property.

5. The Treasurer shall have the custody of all funds of the Academy, He shall keep an account of receipts and disbursements in detail, and this account shall be audited as hereinafter provided.

6. The Academy may elect an *Editor* to supervise all matters connected with the publication of the transactions of the Academy, under the direction of the Council, and to perform the duties of Librarian until such time as the Academy shall make that an independent office.

7. The Council is clothed with executive authority, and with the legislative powers of the Academy in the intervals between the latter's meetings; but no extraordinary act of the Council shall remain in force beyond the next following stated meeting, without ratification by the Academy. The Council shall have control of the publications of the Academy, under the provisions of the By-Laws and of resolutions from time to time adopted. It shall receive nominations for members, and on approval, shall submit such nominations to the Academy for action. It shall have power to fill vacancies *ad interim*, in any of the offices of the Academy.

8. Terms of Office. The President, Vice Presidents, Secretary, Treasurer, and Editor shall be elected annually, and be eligible to re-election without limitation.

ARTICLE V: Voting and Elections.

1. All *elections* shall be by ballot. To elect a Resident Member, Corresponding Member, Honorary Member, or Patron, or impose any special tax shall require the assent of three-fourths of all Resident Members voting.

2. Any member may be expelled by a vote of nine-tenths of all members voting, providing notice that such a movement is contem-

plated be given at a meeting of the Academy three months previous to such action.

3. Election of Members. Nominations for Resident membership shall be made by two Resident Members, according to a form to be provided by the Council. One of these Resident Members must be personally acquainted with the nominee and his qualifications for membership. The Council shall submit the nominations received by them, if approved, to a vote of the Academy at a regular meeting.

4. Election of Officers. Nominations for office shall be made by the Council as provided in the By-Laws. The nominations shall be submitted to a vote of the Academy at its winter [Annual] meeting. The officers thus elected shall enter upon duty at the adjournment of the meeting.

5. At the meeting in which this Constitution is adopted the officers for the ensuing year shall be elected in such manner as the Academy may determine.

ARTICLE VI: Meetings.

1. The Academy shall hold at least two stated meetings a year—a *Summer [or Field] Meeting*, and a *Winter [or Annual] Meeting*. The date and place of each meeting shall be fixed by the Council, and announced by circular at least three months before the meeting. The programme of each meeting shall be determined by the Council, and announced before hand, in its general features. The details of the daily sessions shall also be arranged by the Council.

2. All members must forward to the Secretary, if possible, before the convening of the Academy, full titles of all papers which they propose to present during the meeting, with a statement of the time that each will occupy in delivery and a brief abstract of their contents. From the abstracts thus presented, the Council will determine the fitness of the paper for the programme.

3. Repealed April 1, 1898.

4. Special Meetings of the Academy may be called by the Council, and must be called upon the written request of twenty Resident Members.

5. Stated Meetings of the Council shall be held coincidently with the stated meetings of the Academy. Special meetings of the Council may be called by the President at such time as he may deem necessary.

6. Quorum. At meetings of the Academy a majority of those registered in attendance shall constitute a quorum. Four members shall constitute a quorum of the Council.

ARTICLE VII: Publications.

The publications of the Academy shall be under the immediate control of the Council, but the Council shall accord to each author the right, under proper restrictions, to publish through whatever channel he may choose.

ARTICLE VIII: Sections.

Members not less than eight in number may by special permission of the Academy unite to form a Section for the investigation of any branch of science. Each Section shall bear the name of the science which it represents, thus: The Section of (Agriculture) of the Michigan Academy of Science.

2. Each Section is empowered to perfect its own organization as limited by the Constitution and By-Laws of the Academy.

ARTICLE IX: Amendments.

This Constitution may be amended at any Winter [Annual] meeting by a three-fourths vote of all the Resident Members present.

BY-LAWS.

CHAPTER I: Membership.

1. No person shall be accepted as a Resident Member unless he pay his initiation fee, and the dues for the year, within three months after notification of his election. The initiation fee shall be one (1) dollar and the annual dues one (1) dollar, the latter payable on or before the annual meeting in advance; but a single pre-payment of twenty-five (25) dollars shall be accepted as commutation for life.

2. The sums paid in commutation of dues shall be invested, and the interest used for the ordinary purposes of the Academy during the payer's life, but after his death the sum shall be covered into the Research Fund.

3. An arrearage in payment of annual dues shall deprive a Resident Member of the privilege of taking part in the management of the Academy and of receiving the publications of the Academy. An arrearage continued over two (2) years shall be construed as notification of withdrawal.

4. Any person eligible under Article III of the Constitution, may be elected Patron upon the payment of one hundred (100) dollars to the Research Fund of the Academy.

CHAPTER II: Officials.

1. The President shall countersign, if he approves, all duly authorized accounts and orders drawn on the Treasurer for the disbursement of money.

2. The Secretary, until otherwise ordered by the Academy, shall perform the duties of Editor, Librarian, and Custodian of the property of the Society.

3. The Academy may elect an Assistant Secretary.

4. The Treasurer shall give bonds, with two good sureties approved by the Council, in the sum of five hundred dollars, for the faithful and honest performance of his duties, and the safe-keeping of the funds of the Academy. He may deposit the funds in bank at his discretion, but shall not invest them without the authority of the Council. His accounts shall be balanced on the first day of the Annual Meeting of each year.

5. The minutes of the proceedings of the Council shall be subject to call by the Academy.

CHAPTER III: Election of Members.

1. Nominations for Resident Membership may be proposed at any time on blanks to be supplied by the Secretary.

2. The *form* for the nomination of Resident Members shall be as follows:

In accordance with his desire, we respectfully nominate for Resident Member of the Michigan Academy of Science
(Full name)
(Address)
(Occupation)
(Branch of Science interested in, work already done, and publications if any)
(Signed by at least two Resident Members)

The form when filled is to be transmitted to the Secretary.

3. The Secretary shall bring all nominations before the Council at either the winter [Annual] or summer [Field] meeting of the Academy, and the Council shall signify its approval or disapproval of each.

4. At the same or the next stated meeting of the Academy, the Secretary shall present the list of candidates to the Academy for election.

5. Corresponding Members, Honorary Members, and Patrons shall be nominated by the Council, and shall be elected in the same manner as Resident Members.

CHAPTER IV: Election of Officers.

Section 1. At the Annual Meeting the election of officers shall take place, and the officers elected shall enter on their duties at the end of the meeting.

Section 2. The Council shall nominate a candidate for each office, but each Section may recommend to the Council a candidate for its Vice-President. Additional nominations may be made by any member of the Academy. All elections shall be made by ballot.

Section 3. Repealed.

Section 4. Repealed.

CHAPTER V: Financial Methods.

1. No pecuniary obligation shall be contracted without express sanction of the Academy or the Council. But it is to be understood that all ordinary, incidental and running expenses have the permanent sanction of the Academy, without special action.

2. The creditor of the Academy must present to the Treasurer a fully *itemized* bill, *certified* by the official ordering it, and *approved* by the President. The Treasurer shall then pay the amount out of any funds not otherwise appropriated, and the receipted bill shall be held as his voucher.

3. At each annual meeting, the President shall call upon the Academy to choose two members, not members of the Council, to whom shall be referred the books of the Treasurer, duly posted and balanced to the first day of the Annual Meeting, as specified in the By-Laws, Chapter II, Paragraph 4. These Auditors shall examine the accounts and vouchers of the Treasurer, and any member or members of the Council may be

present during the examination. The report of the Auditors shall be rendered to the Academy before the adjournment of the meeting and the Academy shall take appropriate action.

CHAPTER VI: Publications.

1. The publications are in charge of the Council and under their control, limited only as given by Article VII, of the Constitution.

2. One copy of each publication shall be sent to each Resident Member, Corresponding Member, Honorary Member, and Patron, and each author shall receive fifty copies of his memoir. This provision shall not be understood as including publications in journals not controlled by the Academy.

CHAPTER VII: The Research Fund.

1. The Research Fund shall consist of moneys paid by the general public for publications of the Academy, of donations made in aid of research, and of the sums paid in commutation of dues according to the By-Laws, Chapter I, Paragraphs 2 and 4.

2. Donors to this fund, not Members of the Academy, in the sum of twenty-five dollars, shall be entitled without charge, to the publications subsequently appearing.

CHAPTER VIII: Order of Business.

1. The order of business at the Winter [Annual] Meetings shall be as follows:

(1) Call to order by the Presiding Officer.
(2) Introductory ceremonies.
(3) Statements by the President.
(4) Report of the Council.
(5) Report of the Treasurer, and appointment of the Auditing Committee.
(6) Election of officers of the next ensuing Administration.
(7) Election of Members.
(8) Announcement of the hour and place for the Address of the retiring President.
(9) Necrological notices.
(10) Miscellaneous announcements.
(11) Business motions and resolutions, and disposal thereof.
(12) Reports of committees, and disposal thereof.
(13) Miscellaneous motions and resolutions.
(14) Presentation of memoirs.

2. At an *adjourned session*, the order shall be resumed at the place reached on the previous adjournment, but new announcements, motions and resolutions, will be in order before the resumption of the business pending at the adjournment of the last preceding session.

3. At the Summer [Field] Meeting, the items of business under numbers (5), (6), (8), (9), shall be omitted.

4. At any Special Meeting the Order of Business shall be (1), (2), (3), (7), (10), followed by the special business for which the meeting was called.

CHAPTER IX: Amendments.

These By-Laws may be amended by a majority vote of the members present at any regular meeting.

LIST OF MEMBERS

OF THE

MICHIGAN ACADEMY OF SCIENCE.

Names of actual Resident Members, on June 30, 1900, are preceded by an asterisk (*); names of Charter Members are in capitals.

RESIDENT MEMBERS.

*HENRY C. ADAMS, LL. D., University of Michigan, Ann Arbor.
*HENRY B. BAKER, M. D., Lansing.
*Howard B. Baker, M. D., 281 Warren Ave. W., Detroit.
*CHARLES E. BARR, Albion College, Albion.
*WALTER B. BARROWS, Michigan Agricultural College, Agricultural College. P. O.
*Arthur G. Baumgartel, 232 River St., Holland.
*WILLIAM J. BEAL, PH. D., Michigan Agricultural College, Agricultural College P. O.
*HERBERT T. BLODGETT, Ludington.
Albert H. Boies, Hudson. (Resigned.)
*George Booth, 1102 Center Ave., Bay City.
*Frank Bradley, Alma.
*George M. Bradford, Agricultural College.
*Alice Brown, Ann Arbor.
*William A. Brush, 64 Hastings St.; Detroit.
Mrs. Laura E. Burr, Lansing. (Died May 18, 1900.)
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